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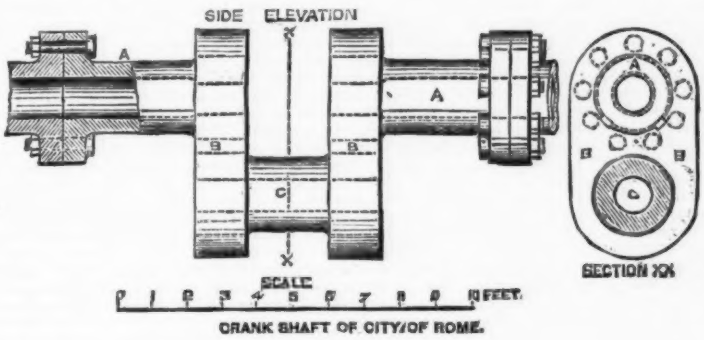
THE GREAT STEAMER CITY OF ROME.

THE City of Rome is the largest mercantile ship afloat, except the Great Eastern; but she is infinitely superior in speed and equipment to what the Great Eastern was in her best days. For the purpose of comparison we may say here that the Great Eastern is 680 ft. long, 83 ft. wide, and 60 ft. deep from the highest part of the hull to the outside of the bottom. She is 22,927 tons builders, 18,915 tons gross, and 13,344 tons net register, and she is propelled by two independent sets of engines, one driving a screw, and the other paddles. The screw engines have four horizontal cylinders, each 84 in. diameter and 4 ft. stroke. They face each other in pairs, there being but two cranks in the shaft. The paddles are propelled by four oscillating cylinders, arranged in pairs facing each other. They are each 74 in. diameter and 14 ft. stroke. To furnish steam to the paddle engines there are four boilers, each 17 ft. 9 in. long, 17 ft. 6 in. wide, and 13 ft. 9 in. high, with 4,400 ft. of tube surface in each. Steam is supplied to the screw engines by six boilers, each 18 ft. 4½ in. long, 17 ft. 6 in. wide, and 14 ft. high; the tube surface is 4,550 square feet, the working pressure 25 lb. on the square inch.

The City of Rome is 586 ft. long, and 52 ft. 3 in. beam, and 37 ft. depth of hold. Her total depth, however, is not much less than 60 ft. Her displacement on 26 ft. draught is 13,500 tons. She is propelled by a four-bladed screw, with a pitch increasing from 36 ft. to 38 ft., and 24 ft. in diameter. She has three tandem compound engines, the high-pressure cylinders being 43 in. and the low-pressure cylinders 86 in. diameter, with a stroke of 6 ft. She has eight double-ended boilers, and forty-eight furnaces, and the safety valve load is 90 lb. to the square inch. A very full description of the ship and engravings of her machinery appeared in THE SCIENTIFIC AMERICAN SUPPLEMENT, No. 248, Oct. 2, 1880. We give this week a view of the ship as she would appear under sail at sea. It will give some idea of her enormous size if we say that her main saloon is 52 ft. wide by 72 ft. long, and 9 ft. high; 248 persons can be seated in it at once.

A volume might be written about this vessel. We must be content with a few lines. Externally the ship is as handsome as a yacht. We question, indeed, if there is a handsomer ship afloat. Our engraving does but scant justice to the elegance of her lines. She has left no doubt in the minds of all those who, like ourselves, have spent three days on board her, that she is the most comfortable steamer in the world, and that nothing short of a very heavy Atlantic gale will make her lively enough to upset a delicate stomach. In anything like moderate weather the ship will be practically quite steady.

It is very difficult, indeed impossible, to convey in words any adequate idea of the spectacle which her engine-room presents. All the received ideas on the subject are completely upset. Four Serrin lamps render it as bright as day. These lamps have no glass shades, and give no trouble. It will, perhaps, help the mind a little to realize what her engines are like when we say that the engine-room is 50 ft. wide by about the same length. The engines are 47 ft. 8 in. high from the bottom of the frames to the tops of the high-pressure cylinders. That is to say, they are as high as an ordinary four-story house. Access is obtained to the engine-room platforms, not by ladders, but by iron staircases, which will take three persons abreast. Entering from the upper deck nothing is to be seen but the three high-pressure cylinders and the lids of the low-pressure cylinders, a close grating concealing all the rest of the machinery below. Descending the first flight of stairs, which runs fore and aft, we are on the second platform, surrounding the low-pressure cylinders, and this is the only hot place in the engine-room. Passing between the cylinders and the flight of steps we have just descended, we come to a second flight, aft of the engines, and running athwartships. We descend to what may be called the third platform, from which access is got to the two stuffing-boxes in the lower lid of each low-pressure cylinder, and standing here and looking forward between the frames we have before us a sight unique in the world. We see the three mighty crossheads with their guides and the jaws of the great connecting rods moving up and down in rhythmical sequence in the vivid glare of the electric lamps, which cast strong shadows on the white bulkheads. Passing on to the lower floor again we have that before us the like of which can nowhere else be seen. There is ample room to walk about; there is no steam to indicate the presence of an engine, for the cylinders are high over our heads. The place is almost chilly. We can look up and see the black covers looming far above. Then straight before us is the crank shaft. We give a drawing of the shaft, to show that it is hollow, and we may add that it is made of Whitworth steel. But as we look at it in the ship we realize that it is the largest crank shaft in the world; it weighs 66 tons. Each of the three cranks, with its shafting, occupies a length of 14 ft., and weighs 22 tons—the weight of a tolerably powerful locomotive. A man, and a tall man too, standing beside one of the cranks, is dwarfed. Each crank pit is a chasm. The rush of water from the pipes over the bearings is caught, and the crank, which has given so much trouble, scatters a light spray, the drops gleaming like jewels in the electric light. The noise is monotonous, but not wearisome. The great connecting rod brasses are just a little slack, and the want of lead in the slides makes the pistons slow in getting away from the cylinder covers; and we have as the cranks revolve not a blow or a knock, but a soft, all-pervading thud, as each center is turned. Away aft runs the great screw shaft. It is 24 in. in diameter. The thrust shaft has twelve collars 4 ft. in diameter. It weighs 17 tons. Following it to the end down the long tunnel, we lose by degrees all the sights and sounds of the ship—the place is cold and weird. Then a noise as of a village water wheel, a gentle pattering and murmuring of water, reaches us. Standing up on an angle iron brace we look through a hole in the last bulkhead in the ship, and we see by the light of an engine-room lamp a small dark pool of water just under the end of the stern tube, and in this pool dips the last coupling, 4 ft. in diameter like its fellows, and the nuts and the heads of the bolts of the coupling patter in the water and make the sounds which have different associations. Then we return to the light and life of the enormous vessel, which will undoubtedly prove as successful as even Messrs. Inman themselves can wish her to be —*The Engineer.*

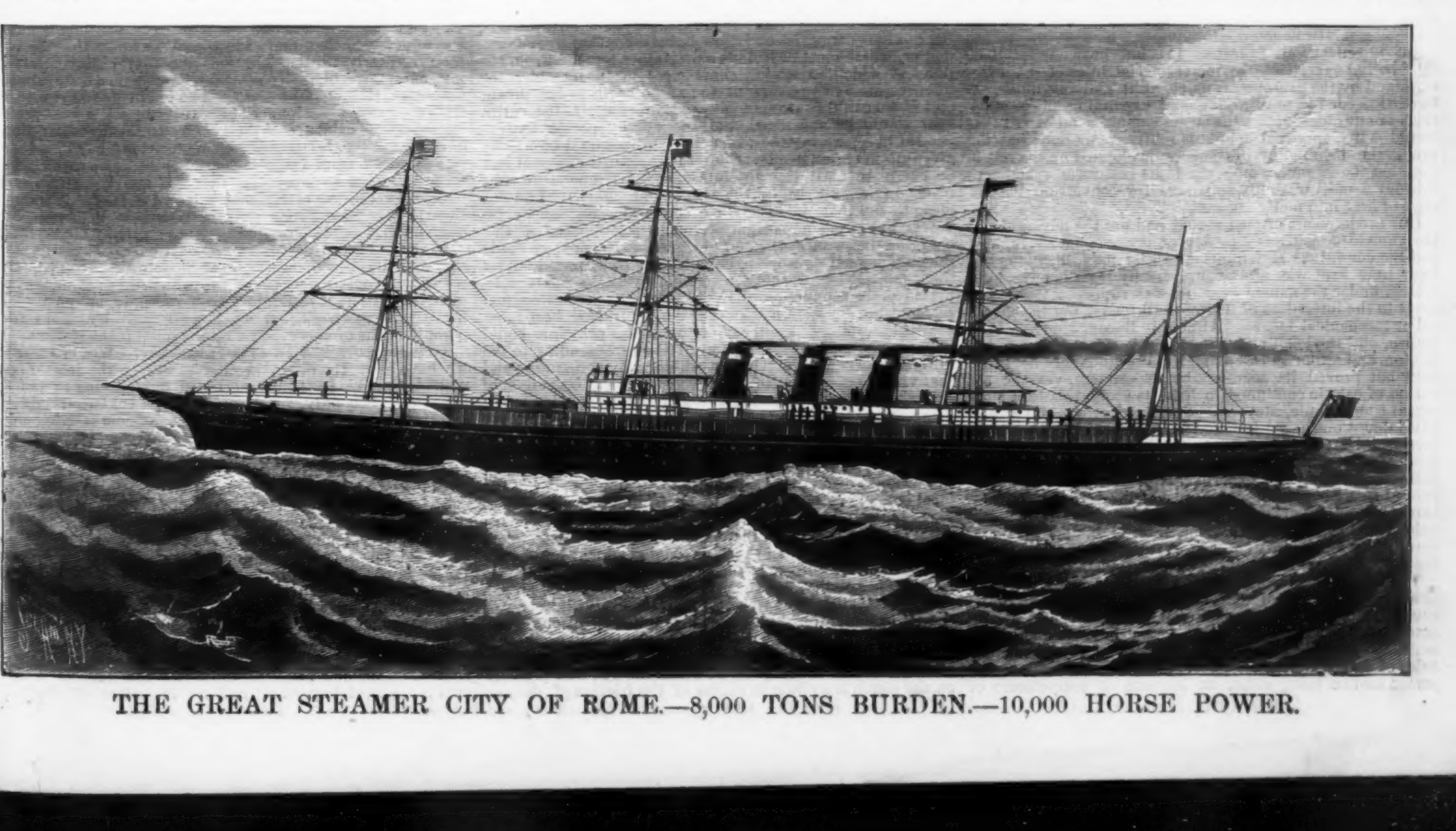


CRANK SHAFT OF CITY OF ROME.

The City of Rome arrived at New York Oct. 24, on her first voyage across the Atlantic, having sailed from Queenstown Oct. 15. She was run at a moderate speed only throughout the passage. She left New York Oct. 29, on her homeward voyage.

LARGE IRON ROOFS.

AT a recent meeting of the Society of Engineers, London, a paper by Mr. Arthur T. Walmisley, on "Iron Roofs," was read, in which the author drew a comparison between some of the principal large roofs in the kingdom. The early types of construction resembled the old timber examples, the only alteration being in their section and detail of



THE GREAT STEAMER CITY OF ROME.—8,000 TONS BURDEN.—10,000 HORSE POWER.

attachment at the joints. The adoption of roofs of large spans was comparatively of recent date. There was still much difference of opinion as to the advisability of single or multiple spans. The advantages of clear spans were (1) freedom from all intermediate supports, giving facilities in laying out the space to the greatest advantage, or in subsequently altering the arrangements, and this freedom is especially valuable when it is required to transfer the traffic of the station from one line to another diagonally at the shortest possible intervals, as at New Street station at Birmingham and other places; (2) getting rid of annoyance of snow lodging in the valleys; and (3) the grander architectural effect of the structure, which was evident by comparing Euston station with St. Pancras station. The roof over the latter station is one clean span of 240 feet, with arched ribs, and this type of construction has been adopted also at the Central station, Manchester, of 210 feet span, and St. Enoch's station, Glasgow, of 198 feet span. Another mode of covering large spaces was to bridge the space to be roofed over with tranverse girders placed at convenient intervals, and to carry the covering on these supports. This plan has been adopted at the Central station, Glasgow, of 213 feet span, and also at Bridge Street station, Glasgow, which was divided into two spans of 114 feet and 49 feet respectively. In both these roofs the covering is on the ridge and furrow system, running longitudinally from end to end. In the Carlisle station, advantage is taken of the necessary longitudinal bracing required to stiffen the transverse girders by placing the gutter midway between the girders, and supporting the slope of the roofs on cantilevers meeting under the gutter, and connected to the main girders at distances of fifteen feet apart, the ridge being carried on the top flange of the girders, and running transversely across the station. There are two spans of 128 feet and 154 feet respectively. The Victoria station of the London, Brighton, and South Coast Railway is divided into two spans of 124 feet and 117 feet respectively. The covering rests on roof trusses of 50 foot spans, supported on girders. The York station, which was about the same width as St. Pancras station, was divided into four spans, and glazed on the ridge and furrow system; but it is open to argument whether this was the best way to glaze or not. When the ridge and furrow follow the curve or slope of the roof, one side of the sash bar suffers more from the weather than the other, and wears away the putty; but the author considered that the systems of glazing without putty ought universally to be adopted, and that a glazier's tools should never be used in construction, as it was easy in design to ascertain manufacturers' sizes, and work them in accordingly. Various patents had been taken out for glazing without putty. That by the late Mr. Rendle, who was the originator of the system, had been largely used in many roofs of large and small dimensions, and its merits were well known. Another system, patented by Mr. T. W. Helliwell, was also worthy of description, though not so extensively used as Rendle's system. In the design of a roof, the importance of all parts being as much as possible accessible to a painter's brush should be borne in mind. The construction of expansion roller frames was still very unsatisfactory, as rollers were so often found to rust in their bearings under the foot of the rafter. The roof over the Bristol station was a good and economical form of a rigid arch. No provision was in this case necessary for variations under change of temperature, as the ridge, by the construction, would rise and fall with the structure without spreading at the feet. It is unnecessary to spread wind ties offensively all over a roof as was generally done. It is sufficient to connect the end bays, as was done in the Earl's Court station of the Metropolitan District Railway, the Drill Hall, Edinburgh, and other recently erected roofs, and trust to the purline connections, which should be arranged to give the required stiffness to the intermediate bays of the roof. The general use of iron in works of construction renders it desirable to arrive at the best form to adopt in different cases consistent with efficiency and economy, and much might be learnt by comparing different systems that have been adopted both in trussed and arched roofs.

MECHANICAL SCIENCE.

OPENING ADDRESS BY SIR W. ARMSTRONG, C.B., D.C.L., LL.D., F.R.S., PRESIDENT OF SECTION G, BRITISH ASSOCIATION, YORK, 1881.

THE astonishing progress which has been made in the construction and application of machinery during the half century which has elapsed since the nativity of the British Association for the Advancement of Science is a theme which I might with much complacency adopt in this address, but instead of reviewing the past and exulting in our successes, it will be more profitable to look to the future and to dwell on our failures. It is but justice to say that, by growing experience, by increasing facilities of manufacture, and by the exercise of much skill and ingenuity, we have succeeded in multiplying and expanding the applications of our chief motor, the steam engine, to an extent that would have appeared incredible fifty years ago; but the gratulation inspired by this success is clouded by the reflection that the steam engine, even in its best form, remains to this day a most wasteful apparatus for converting the energy of heat into motive power.

Our predecessors of that period had not the advantage of the knowledge which we possess of the true nature of heat and the conditions and limits affecting its utilization. In their time heat was almost universally regarded as a fluid which, under the name of caloric, was supposed to lie dormant in the interstices of matter until forced out by chemical or mechanical means. Although Bacon, Newton, Cavendish, and Boyle all maintained that heat was only internal motion, and although Davy and Rumford not only held that view but proved its accuracy by experiment, yet the old notion of caloric continued to hold its ground until in more recent times Joule, Meyer, Codling, and others put an end to all doubt on the subject, and established the all-important fact that heat is a mode of motion, having, like any other kind of motion, its exact equivalent in terms of work. By their reasonings and experiments it has been definitely proved that the quantity of heat which raises the temperature of a pound of water 1° Fahrenheit has a mechanical value equal to lifting 772 lb. one foot high, and that conversely the descent of that weight from that height is capable of exactly reproducing the heat expended.

The mechanical theory of heat is now universally accepted, although a remnant of the old doctrine is displayed in the continued use of the misleading term "latent heat." According to the new theory, heat is an internal motion of molecules capable of being communicated from the molecules of one body to those of another, the result of the imparted motion being either an increase of temperature or the performance of work. The work may be either external, as where heat, in expanding a gas, pushes away a resisting body, or it may be internal, as where heat pulls asunder the cohering particles of ice in the process of liquefaction, or it may be partly internal and partly external, as it is in the steam engine, where the first effect of the heat is to separate the particles of water into vapor, and the second to give motion to the piston. Internal as well as external work may be reconverted into heat, but until the reconversion takes place the heat which did the work does not exist as heat, and it is delusive to call it "latent heat." All heat problems are comprised under the three leading ideas of internal work, external work, and temperature, and no phraseology should be used that conflicts with those ideas.

The modern theory of heat has thrown new light upon the theory of the steam engine. We now know what is the mechanical value in foot pounds of the heat evolved in the combustion of one pound of coal. In practice we can determine how much of that heat is transmitted to the water in the boiler, and we are taught how to calculate the quantity which in the process of vaporization takes the form of internal work. We can determine how much disappears in the engine in the shape of external work, including friction, and the remainder, with the exception of the trifling quantity saved in the feed water, we know to be lost. Taking a good condensing engine as an example, we may roughly say that, dividing the whole heat energy into ten equal parts, two escape by the chimney, one is lost by radiation and friction, six remain unused when the steam is discharged, and only one is realized in useful work. It may be fully admitted that the greater part of the aggregate loss is inevitable; but are we to suppose that the resources of science, ingenuity, and skill have been exhausted in the attainment of so miserable a result? Nothing but radical changes can be expected to produce any great mitigation of the present monstrous waste, and without presuming to say what measures are practicable and what are not, I will briefly point out the directions in which amelioration is theoretically possible, and shall afterward advert to the question whether we may hope to evade the difficulties of the steam engine by resorting to electrical methods of obtaining power.

To begin with the loss which takes place in the application of heat to the boiler: Why is it that we have to throw away, at the very outset of our operations, twice as much heat as we succeed in utilizing in the engine? The answer is, that in order to force a transmission of heat from the fire to the water in the boiler, a certain excess of temperature over that of the water must exist in the furnace and flues, and the whole of the heat below the required excess must pass away unused, except the trifling portion of it which disappears in the production of draught. Further, that since we cannot avoid admitting the nitrogen of the air along with the oxygen, we have to heat a large volume of neutral gas which has no other effect than to rob the fire. Considering what efforts have been made to facilitate the transmission of the heat by augmenting the evaporative surface and using thin tubes as flues, it is vain to expect any great result from further perseverance in that direction; and unless a method can be devised of burning the fuel inside instead of outside the apparatus, so as to use the heated gases conjointly with the steam as a working medium in the engine, a remedy appears to be hopeless.

We already practice internal combustion in the gas engine, and it is clear that with gaseous fuel, at all events, we could associate such a mode of combustion with the vaporization of water. We may even regard a gun as an engine with internally burnt fuel; and here I may remark that the action of heat in a gun is strictly analogous to that of heat in a steam engine. In both cases the heat is evolved from chemical combination, and the resulting pressures differ only in degree. The gun is the equivalent of the cylinder, and the shot of the piston, and the diagrams representing the pressure exerted in the two cases bear a close resemblance to each other. While the powder is burning in the gun we have a nearly uniform pressure, just as we have in the cylinder while the steam is entering; and in both cases the uniform pressure is followed by a diminishing pressure, represented by the usual curve of expansion.

If in the steam engine we allowed the piston to be blown out it would act as a projectile, and if in the gun we opposed mechanical resistance to the shot, we might utilize the effect in a quieter form of motive power. But it is a remarkable fact that such is the richness of coal as a store of mechanical energy that a pound of coal, even as used in the steam engine, produces a dynamic effect about five times greater than a pound of gunpowder burnt in a gun. I cannot, however, on this account encourage the idea that steam may be advantageously substituted for gunpowder in the practice of gunnery.

And now to turn from the fire which is the birthplace of the motive energy, let us follow it in the steam to the condenser, where most of it finds a premature tomb. From the point at which expansion commences in the cylinder the temperature and pressure of the steam begin to run down, and if we could continue to expand indefinitely, the entire heat would be exhausted, and the energy previously expended in separating the water into steam would be wholly given up in external effect; but this exhaustion would not be complete until the absolute zero of temperature was reached (viz., 461° below the zero of Fahrenheit). I do not mean to say that an ideally perfect engine necessarily involves unlimited expansion, seeing that if, instead of discharging the steam at the end of a given expansion, we made the engine itself do work in compressing it, we might, under the conditions of Carnot's reversible cycle, so justly celebrated as the foundation of the theory of the steam engine, recommence the action with all the unutilized heat in an available form. But an engine upon this principle could only give an amount of useful effect corresponding to the difference between the whole work done by the engine and that very large portion of it expended in the operation of compression, and this difference viewed in relation to the necessary size of the engine would be quite insignificant and would in fact be wholly swallowed up in friction.

Carnot did not intend to suggest a real engine, and his hypothesis, therefore, takes no cognizance of losses incident to the application of an actual fire to an actual boiler. His ideal engine is also supposed to be frictionless and impervious to heat except at the point where heat has to be transmitted to the water, and there the condition of perfect conduction is assumed. In short, an engine which would even approximately conform to the conditions of Carnot's cycle is an impossibility, and a perfect steam engine is alike a phantom whether it be sought for in the cyclical process of Carnot or under the condition of indefinite expansion. Practically we have to deal with a machine which, like all other machines is subject to friction; and in expanding the steam we quickly arrive at a point at which the reduced pressure on the piston is so little in excess of the friction of the machine as to render the steam not worth retaining, and at this point we reject it. In figurative language, we take the cream off the bowl and throw away the milk.

We do save a little by heating the feed water, but this gain is very small in comparison with the whole loss. What happens in the condenser is, that all the remaining energy which has taken the form of internal work is reconverted into heat, but it is heat of so low a grade that we cannot apply it to the vaporization of water. But although the heat is too low to vaporize water it is not too low to vaporize ether. If, instead of condensing by the external application of water, we did so by the similar application of ether, as proposed and practiced by M. du Trembley twenty-five years ago, the ether would be vaporized, and we should be able to start afresh with high tension vapor, which in its turn would be expanded until the frictional limit was again reached. At that point the ether would have to be condensed by the outward application of cold water and pumped back in the liquid state to act over again in a similar manner.

This method of working was extensively tried in France when introduced by M. du Trembley, and the results were sufficiently encouraging to justify a resumption of the trials at the present time, when they could be made under much more favorable conditions. There was no question as to the economy effected, but in the discussions which took place on the subject it was contended that equally good results might be attained by improved applications of the steam without resorting to an additional medium. The compound engine of the present day does in fact equal the efficiency of Du Trembley's combined steam and ether engine, but there is no reason why the ether apparatus should not confer the same advantage on the modern engine that attended its application to the older form. The objections to its use are purely of a practical nature, and might very possibly yield to persevering efforts at removal.

I need scarcely notice the advantage to be derived from increasing the initial pressure of the steam so as to widen the range of expansion by raising the upper limit of temperature instead of reducing the lower one. It must be remembered, however, that an increase of temperature is attended with the serious drawback of increasing the quantity of heat carried off by the gases from the fire, and also the loss by radiation, so that we have not so much to gain by increase of pressure as is commonly imagined.

But even supposing the steam engine to be improved to the utmost extent that practical considerations give us reason to hope for, we should still have to adjudge it a wasteful though a valuable servant. Nor does there appear to be any prospect of substituting with advantage any other form of thermodynamic engine, and thus we are led to inquire whether any other kind of energy is likely to serve us better than heat for motive power.

Most people, especially those who are least competent to judge, look to electricity as the coming panacea for all mechanical deficiency; and certainly the astonishing progress of electricity as applied to telegraphy and to those marvelous instruments of recent invention which the British Post Office claims to include in its monopoly of the electric telegraph, as well as the wonderful advance which electricity has made as an illuminating agent, does tend to impress us with faith in its future greatness in the realm of motive power as well.

The difference between heat and electricity in their modes of mechanical action is very wide. Heat acts by expansion of volume, which we know to be a necessarily wasteful principle, while electricity operates by attraction and repulsion, and thus produces motion in a manner which is subject to no greater loss of effect than attends the motive action of gravity as exemplified in the ponderable application of falling water in hydraulic machines. If then we could produce electricity with the same facility and economy as heat the gain would be enormous, but this, as yet at least, we cannot do. At present, by far the cheapest method of generating electricity is by the dynamic process. Instead of beginning with electricity to produce power, we begin with power to produce electricity. As a secondary motor an electric engine may, and assuredly will, play an important part in future applications of power, but our present inquiry relates to a primary, and not a secondary, employment of electricity.

Thus we are brought to the question, From what source, other than mechanical action, can we hope to obtain a supply of electricity sufficiently cheap and abundant to enable it to take the place of heat as a motive energy? It is commonly said that we know so little of the nature of electricity that it is impossible to set bounds to the means of obtaining it; but ignorance is at least as liable to mislead in the direction of exaggerated expectation as in that of incredulity. It may be freely admitted that the nature of electricity is much less understood than that of heat, but we know that the two are very nearly allied. The doctrine that heat consists of internal motion of molecules may be accepted with almost absolute certainty of its truth. The old idea of heat being a separate entity is no longer held except by those who prefer the fallacious evidence of their senses to the demonstrations of science. So also the old idea of electricity having a separate existence from tangible matter must be discarded, and we are justified in concluding that it is merely a strained or tensional condition of the molecules of matter. Although electricity is more prone to pass into heat than heat into electricity, yet we know that they are mutually convertible.

In short, I need scarcely remind you that, according to that magnificent generalization of modern times so pregnant with great consequences, and for which we are indebted to many illustrious investigators, we now know that heat, electricity, and mechanical action are all equivalent and transposable forms of energy, of which motion is the essence.

To take a cursory view of our available sources of energy, we have, first, the direct heating power of the sun's rays, which as yet we have not succeeded in applying to motive purposes. Secondly, we have water power, wind power, and tidal power; all depending upon influences lying outside of our planet. And, thirdly, we have chemical attraction or affinity. Beyond these there is nothing worth naming. Of the radiant heat of the sun I shall have to speak hereafter; and bearing in mind that we are in search of electricity as a cause, and not an effect, of motive power, we may pass over the dynamical agencies comprised under the second head, and direct our attention to chemical affinity as the sole remaining source of energy available for our purpose. At present we derive motive power from chemical attraction through the medium of heat only, and the question is, Can we with advantage draw upon the same source through the medium of electricity? The process by which we obtain our supply of heat from the exercise of affinity is that of combustion, in which the substances used consist, on the one hand, of those we call fuel, of which coal is the most important; and on the other, of oxygen,

which we derive from the atmosphere. The oxygen has an immense advantage over every other available substance, in being omnipresent and costless. The only money value involved is that of the fuel, and in using coal we employ the cheapest oxidizable substance to be found in nature. Moreover, the weight of coal used in the combination is only about one-third of the weight of oxygen, so that we only pay upon one-fourth of the whole material consumed. Thus we have conditions of the most favorable description for the production of energy in the form of heat, and if we could only use the affinities of the same substances with equal facility to evolve electric energy instead of heat energy, there would be nothing more to desire, but as yet there is no appearance of our being able to do this.

According to our present practice we consume zinc, instead of coal, in the voltaic production of electricity, and not only is zinc thirty or forty times dearer than coal, but it requires to be used in about sixfold larger quantity in order to develop an equal amount of energy. Some people are bold enough to say that with our present imperfect knowledge of electricity we have no right to condemn all plentiful substances, other than coal, as impracticable substitutes for metallic zinc, but it is manifest that we cannot get energy from affinity, where affinity has already been satisfied. The numerous bodies which constitute the mass of our globe, and which we call earths, are bodies in this inert condition. They have already, by the union of the two elements composing them, evolved the energy due to combination, and that energy has ages ago been dissipated in space in the form of heat, never again to be available to us. As well might we try to make fire with ashes, as to use such bodies over again as sources of either heat or electricity. To make them fit for our purpose we should first have to annul their state of combination, and this would require the expenditure of more energy upon them than we could derive from their recombination. Water, being oxidized hydrogen, must be placed in the same category as the earths. In short the only abundant substances in nature possessing strong unsatisfied affinities are those of organic origin, and in the absence of coal, which is the accumulated product of a past vegetation, our supply of such substances would be insignificant. This being the case, until a means be found of making the combination of coal with oxygen directly available for the development of electric energy, as it now is of heat energy, there seems to be no probability of our obtaining electricity from chemical action at such a cost as to supplant heat as a motive agent

But while still looking to heat as the fountain-head of our power, we may very possibly learn to transmute it, economically, into the more available form of electricity. One method of transformation we already possess, and we have every reason to believe there are others yet to be discovered. We know that when dissimilar metals are joined at opposite ends, and heated at one set of junctions while they are cooled at the other, part of the heat applied disappears in the process, and assumes the form of an electric current. Each couple of metals may be treated as the cell of a voltaic battery, and we may multiply them to any extent, and group them in series or in parallels, with the same results as are obtained by similar combinations of voltaic cells. The electricity so produced we term thermo-electricity, and the apparatus by which the current is evolved is the thermo-electric battery. At present this apparatus is even more wasteful of heat than the steam-engine, but considering the very recent origin of this branch of electrical science, and our extremely imperfect knowledge of the actions involved, we may reasonably regard the present thermo-electric battery as the infant condition of a discovery, which, if it follow the rule of all previous discoveries in electricity, only requires time to develop into great practical importance. Now, if we possessed an efficient apparatus of this description we could at once apply it to the steam-engine for the purpose of converting into electric energy the heat which now escapes with the rejected steam and the gases from the fire The vice of the steam-engine lies in its inability to utilize heat of comparatively low grade, but if we could use up the leavings of the steam-engine by a supplemental machine acting on thermo-electric principles, the present excessive waste would be avoided. We may even anticipate that in the distant future a thermo-electric engine may not only be used as an auxiliary, but in complete substitution of the steam-engine. Such an expectation certainly seems to be countenanced by what we may observe in animated nature. An animal is a living machine dependent upon food both for its formation and its action. That portion of the food which is not used for growth or structural repair acts strictly as fuel in the production of heat. Part of that heat goes to the maintenance of the animal temperature, and the remainder gives rise to mechanical action. The only analogy between the steam engine and this living engine is that both are dependent upon the combustion of fuel, the combustion in the one case being extremely slow, and in the other very rapid. In the steam-engine the motion is produced by pressure, but in the animal machine it is effected by muscular contraction. The energy which causes that contraction, if not purely electrical, is so much of that nature that we can produce the same effect by electricity. The conductive system of the nerves is also in harmony with our conception of an electrical arrangement.

In fact a description of the animal machine so closely coincides with that of an electro-dynamic machine, actuated by thermo-electricity, that we may conceive them to be substantially the same thing. At all events, the animal process begins with combustion and ends with electrical action, or something so nearly allied to it as to differ only in kind. And now observe how superior the result is in nature's engine to what it is in ours. Nature only uses heat of low grade, such as we find wholly unavailable. We reject our steam as useless, at a temperature that would cook the animal substance, while nature works with a heat so mild as not to hurt the most delicate tissue. And yet, notwithstanding the greater availability of high-grade temperature, the quantity of work performed by the living engine, relatively to the fuel consumed, puts the steam-engine to shame. How all this is done in the animal organization we do not yet understand, but the result points to the attainability of an efficient means of converting low grade heat into electricity; and in striving after a method of accomplishing that object we shall do well to study nature, and profit by the excellence which is there displayed.

But it is not alone in connection with a better utilization of the heat of combustion that thermo-electricity bears so important an aspect, for it is only the want of an efficient apparatus for converting heat into electricity that prevents our using the direct heating action of the sun's rays for motive power. In our climate, it is true, we shall never be able to depend upon sunshine for power; nor need we repine on that account so long as we have the preserved sunbeams which we possess in the condensed and portable form of coal; but in regions more favored with sun and less provided with coal the case would be different. The actual power of the sun's rays is enormous, being computed to be equal to melting a crust of ice 103 feet thick over the whole earth in a year. Within the tropics it would be a great deal more, but a large deduction would everywhere have to be made for absorption of heat by the atmosphere. Taking all things into account, however, we shall not be far from the truth in assuming the solar heat, in that part of the world, to be capable of melting annually, at the surface of the ground, a layer of ice 85 feet thick. Now let us see what this means in mechanical effect. To melt 1 lb. of ice requires 142·4 English units of heat, which, multiplied by 772, gives us 109,932 foot pounds as the mechanical equivalent of the heat consumed in melting a pound of ice. Hence we find that the solar heat, operating upon an area of one acre, in the tropics, and competent to melt a layer of ice 85 feet thick in a year, would, if fully utilized, exert the amazing power of 4,000 horses acting for nearly nine hours every day.

In dealing with the sun's energy we could afford to be wasteful. Waste of coal means waste of money and premature exhaustion of coal-beds. But the sun's heat is poured upon the earth in endless profusion—endless at all events in a practical sense, for whatever anxiety we may feel as to the duration of coal, we need have none as to the duration of the sun. We have therefore only to consider whether we can divert to our use so much of the sun's motive energy as will repay the cost of the necessary apparatus; and whenever such an apparatus is forthcoming we may expect to bring into subjection a very considerable proportion of the 4,000 invisible horses which science tells us are to be found within every acre of tropical gound.

But whatever may be the future of electricity as a prime mover, either in a dominant or subordinate relation to heat, it is certain to be largely used for mechanical purposes in a secondary capacity, that is to say, as the offspring instead of the parent of motive power. The most distinctive characteristic of electricity is that which we express by the word "current," and this gives it great value in cases where power is required in a transmissible form. The term may be objected to as implying a motion of translation analogous to the flow of a liquid through a pipe, whereas the passage of electricity through a conductor must be regarded as a wave-like action communicated from particle to particle. In the case of a fluid current through a pipe, the resistance to the flow increases as the square of the velocity, while in the case of an electric current the resistance through a given conductor is a constant proportion of the energy transmitted. So far, therefore, as resistance is concerned electricity has a great advantage over water for the transmission of power. The cost of the conductor will, however, be a grave consideration where the length is great, because its section must be increased in proportion to the length to keep the resistance the same. It must also be large enough in section to prevent heating, which not only represents loss but impairs conductivity. To work advantageously on this system, a high electromotive force must be used, and this will involve loss by imperfect insulation increasing in amount with the length of the line. For these reasons there will be a limit to the distance to which electricity may be profitably conveyed, but within that limit there will be wide scope for its employment transmissively. Whenever the time arrives for utilizing the power of great waterfalls the transmission of power by electricity will become a system of vast importance. Even now small streams of water inconveniently situated for direct application may, by the adoption of this principle, be brought into useful operation.

For locomotive purposes also we find the dynamo-electric principle to be available, as instanced in the very interesting example presented in Siemens' electric railway, which has already attained that degree of success which generally foreshadows an important future. It forms a combined fixed engine and locomotive system of traction, the fixed engine being the generator of the power and the electric engine representing the locomotive.

Steam power may both be transmitted and distributed, by the intervention of electricity, but it will labor under great disadvantage when thus applied, until a thoroughly effective electric accumulator be provided, capable of giving out electric energy with almost unlimited rapidity. How far the secondary battery of M. Faure will fulfill the necessary conditions remains to be seen, and it is to be hoped that the discussions which may be expected to take place at this meeting of the British Association will enable a just estimate of its capabilities to be formed. The introduction of the Faure battery is at any rate a very important step in electrical progress. It will enable motors of small power, whatever their nature may be, to accomplish, by uninterrupted action, the effect of much larger machines acting for short periods, and by this means the value of very small streams of water will be greatly enhanced. This will be especially the case where the power of the stream is required for electric lighting, which, in summer, when the springs are low, will only be required during the brief hours of darkness, while in winter the longer nights will be met by a more abundant supply of water. Even the fitful power of wind, now so little used, will probably acquire new life when aided by a system which will not only collect, but equalize, the variable and uncertain power exerted by the air.

It would greatly add to the utility of the Faure battery if its weight and size could be considerably reduced, for in that case it might be applicable to many purposes of locomotion. We may easily conceive its becoming available in a lighter form for all sorts of carriages on common roads, thereby saving to a vast extent the labor of horses. Even the nobler animal that strides a bicycle, or the one of fainter courage that prefers the safer seat of a tricycle, may ere long be spared the labor of propulsion, and the time may not be distant when an electric horse, far more amenable to discipline than the living one, may be added to the bounteous gifts which science has bestowed on civilized man.

In conclusion I may observe that we can scarcely sufficiently admire the profound investigations which have revealed to us the strict dynamical relation of heat and electricity to outward mechanical motion. It would be a delicate task to apportion praise among those whose labors have contributed, in various degrees, to our present knowledge; but I shall do no injustice in saying that of those who have expounded the modern doctrine of energy, in special relation to mechanical practice, the names of Joule, Clausius, Rankine, and William Thomson, will always be conspicuous. But up to this time our knowledge of energy is almost confined to its inorganic aspect. Of its physiological action we remain in deep ignorance, and as we may expect to derive much valuable guidance from a knowledge of nature's methods of dealing with energy in her wondrous mechanisms, it is to be hoped that future research will be directed to the elucidation of that branch of science which as yet has not even a name, but which I may provisionally term "Animal Energetics."

THE SMALL-ARM FACTORY AT ENFIELD.

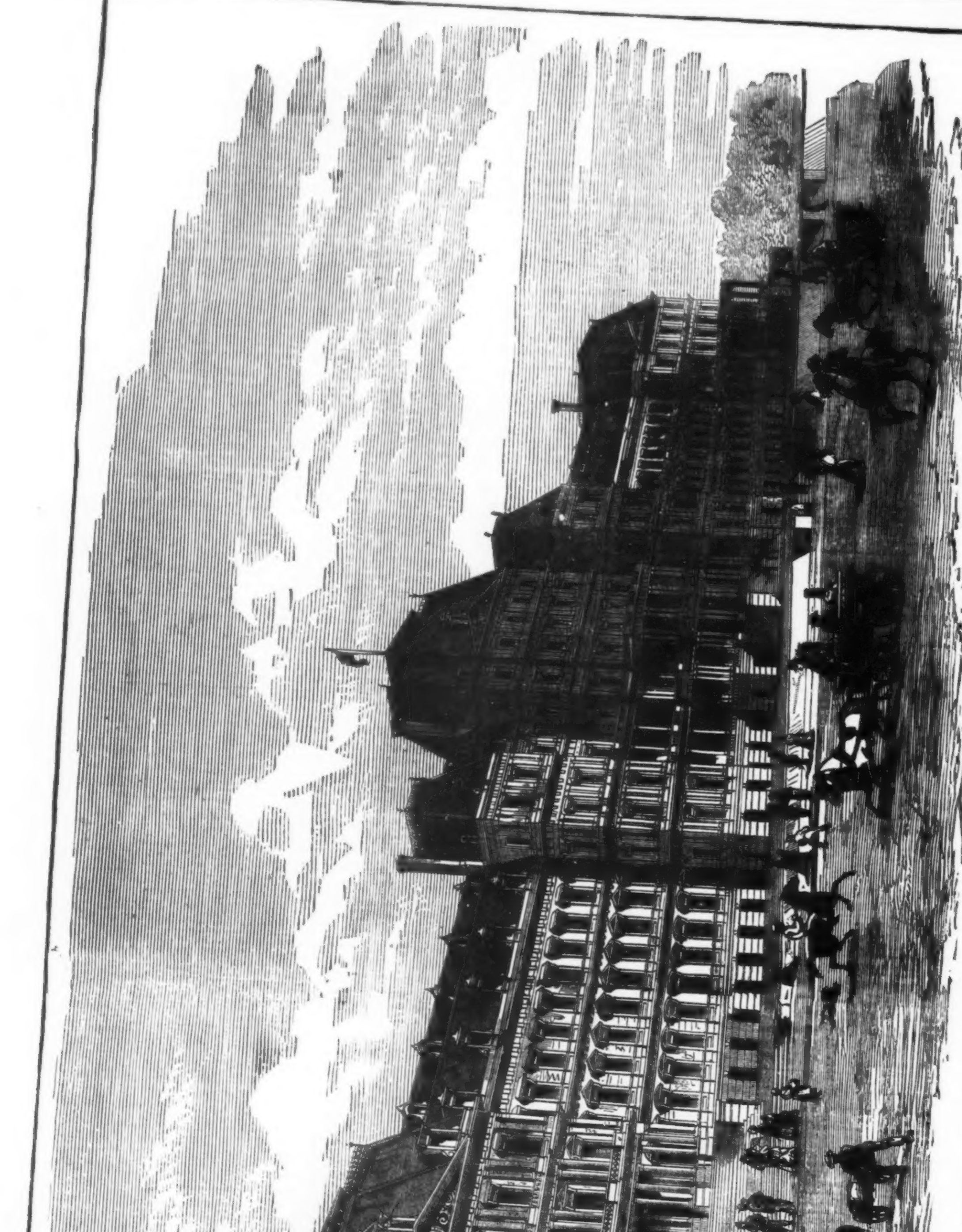
The Enfield rifle factory is a very complete establishment, with features peculiar to itself, but of general interest to the Iron and Steel Institute. The superintendent is Col. Arbuthnot, R. A. As it stands at present, it is capable of turning out in the week 2,000 rifles complete, working the ordinary hours. By working overtime, the number can be increased to 3,000, and by the employment of "shifts," working night and day, 5,000 pieces may be made in the week. The branch of the establishment that would be most likely to keep the whole back is the forge or smithery, where the men have, when under pressure, to work rather too close together. Such a rate of manufacture, if long continued, would doubtless meet almost any demand. In case of a serious war, however, we doubt whether the store of rifled muskets in the country would suffice even for immediate wants, and certainly for a few weeks or months the demand for arms is likely to be very severe, and it is a question whether Enfield would have time enough allowed to meet it. Hence it follows that private firms deserve and obtain a measure of encouragement, though the orders given to them can hardly repay them for the cost of establishing machinery capable of making interchangeable arms of the service Martini-Henry pattern. The private firms that have supplied arms by contract are three, the London Armory Company, the Birmingham Small-arms Company, and the Birmingham National Company.

The prominent characteristic features of Enfield are as follows:

Every part of a rifle is made interchangeable with the corresponding part in any other rifle of the same pattern. Machinery is employed to so large an extent that the number of skilled mechanics is but few. The bulk of the machine work is milling. Revolving cutters, termed milling tools, are shaped to the profile required for the part to be made; of course, in many cases, the edge has to be cut by two or three different shaped milling tools, and a rough and a fine milling tool are always employed for the same part and shape. This system requires very highly skilled mechanics in the machine shop, but when the tools have been adjusted by them, an intelligent laborer can work with them. The machinery, which is excellent, was brought over nearly complete from America, many years since, but has been improved here and there. It is said, for example, that the Americans failed in all attempts to drill the hole in the stock for the end of the "cleaning rod" by machinery, the bit gradually deviating from its true course in boring so long a hole. This difficulty is met here and in similar cases by making the work revolve on the same axis as that of the hole to be drilled, which keeps the bit true. The barrels also are now differently made altogether from what they were when the machinery was first erected at Enfield. The present system of manufacture, which was introduced by Colonel Close, deserves notice. The barrels were formerly made of the best wrought iron, each one commencing in the form of a flat piece, termed a "skelp," weighing 8¼ lb., which was bent under rolls into a hollow cylinder and drawn out as far as was required. Boring out followed. Now the barrel is supplied in the form of a solid rod of steel, and worked to the requisite form and degree of taper by means of a system of rolls placed in a train with small carriers between them so arranged that the steel rod, or skelp, as it is still termed, passes in one heat through the entire train, coming to each roll at a certain exact point on its circumference, and thus receiving its required taper as well as its lump being formed in one short process. Every alternate pair of rolls have their axis vertical, so as to prevent the barrel from becoming oval in section. After receiving its external form, it is bored out by successive bits, the work revolving on its own axis, which, of course, coincides with that of the bit. This plant is comparatively new. As regards the general work of the department, it is difficult to select special features in machinery which is throughout of much the same character. Almost all processes embody the application of the principle of copying by milling tools to one or another part of the rifle, and all the machines work to nearly the same high standard of accuracy. Those who are interested in such matters might with advantage inquire as to the wear of the various tools working under these favorable conditions. It may be here noticed, by the way, that at one time the oil supposed to be necessary for the machines was supplied by the department, but the experiment was tried of arranging for the men to purchase it from the department as they required it, when it was found that only about one-twelfth of the quantity hitherto used was expended. Instances of spiral springs which have been constantly in motion, and have lasted for a surprisingly long time, will, we believe, be found.

Those who are interested in the rifle as an arm not merely as an article of manufacture have, of course, much to see, especially in the inspection department. "Shading" barrels is a test of the accuracy of any eye. Rifles are now sighted up to much longer ranges than formerly, some, we believe, up to 1,400 yards. It is therefore found necessary to set the sight sufficiently obliquely on the barrel to allow for the "derivation" of the bullet to the right arising from the rotation imparted to it. Most valuable information as to difficulties occurring from "misfires" and the like may be obtained. Probably most visitors would be interested in the machine gun question, on which some remarkable trials were made at Enfield. Those of special practical interest, we think, related to the curious effect of deterioration on the action in very rapid firing. It was found that a charge might act sharply and discharge its bullet well from a certain piece, which, in the case of slightly sluggish action, lodged its bullet half way up the barrel, the fact being that the breech supported the cartridge for so short a time that unless the charge acted very sharply the cartridge was unsupported. Another curious fact was the danger arising from powder still burning in the cartridge ejected in very rapid firing. Altogether, any visitor who is a judge of manufacturing questions will feel that in the accuracy of work, system, and economy, Enfield is a successful factory. —*The Engineer.*

Diphtheria.—Dr. Gauthier, of St. Paul, Minn., tells in the Chicago *Medical Review* of his success in an epidemic of diphtheria by the use of iodine. The treatment is as follows: The patient is ordered tincture iodine in ten to twelve drop doses every hour, well diluted with water, so long as the fever lasts, subsequently reducing to ten drops every two, and finally every three hours. Local applications are made use of at least twice a day.



THE ARMY AND NAVY BUILDINGS, WASHINGTON.

THE ARMY AND NAVY BUILDING AT WASHINGTON.

THE magnificent structure known as the Army and Navy Building, in Washington, is located just west of the Presidential mansion. The building is in the Roman-Doric style, of granite, 471 feet long, 253 feet wide, but including projections and steps, it is 567 feet long, 342 feet wide, and 128 feet high. It has four façades. It was begun in 1871. For our illustration we are indebted to the *Illustrated London News*.

ELECTRIC LIGHTING BY INCANDESCENCE.*

By J. SWAN.

EVER since Sir H. Davy showed that a brilliant and continuous light could be produced by causing the current from a voltaic battery to pass between two points of charcoal, the application of electric light to useful purposes has been one of the chief aims of electrical experimentalists. But it is within the last twenty years, or since mechanicians and electricians combined to make it possible to produce electricity by mechanical means, that the idea of useful electric illumination has been brought within the scope of practicality.

The difficulty of producing electric light with carbon points was to make it steady, and to moderate its excessive brilliance. By dint of improvements in the form and quality of charcoal points, and ingenious mechanism for maintaining the points of these pencils at a constant distance from each other, the first of these difficulties has to a very large extent been overcome. But the second one has remained, and from the very nature of the case must remain, as an insuperable obstacle to the application of this form of electric light to the general purposes of artificial illumination.

I do not intend to convey the opinion that the form of electric light to which I am referring is not in some cases a useful form. It would be absurd to express such an opinion in the presence of those who have witnessed the splendid illumination of the railway stations and streets of London, and by these means.

What I say is this, that that form of electric light is only exceptionally applicable; that it leaves the greater number and the more important of our wants in respect of artificial light unprovided for. It is, in my opinion, quite inapplicable to domestic lighting, and it is there that we experience the most keenly the evils of the existing modes of artificial illumination by means of gas and oil lamps. In order to adapt electric light to house illumination it is necessary to entirely change the method of producing it.

Starr was the first to conceive the idea that it might be possible to produce an electric light both small and steady by heating to a white heat a thin piece of carbon. Starr's proposal was to put a thin plate of carbon in the vacuum of a mercury barometer, and to keep it in a state of white heat by passing an electric current through it.

The difference between the two systems I have mentioned is this: In the first in which light is produced by a disruptive electric discharge between points of carbon there is a break in the circuit so far as solid material is concerned at the place where the light occurs.

In the other, the solid conductor is quite continuous, but at the place where light is produced the conductor has a high degree of resistance. At that place the conductor is carbon, and as carbon is comparatively with metals a bad conductor it happens that when an electric current is forced through this circuit a certain amount of electricity is converted into heat in the carbon. If the quantity which passes in a given time is large enough in proportion to the mass of carbon it becomes white hot and emits light.

Electric light produced on this principle of incandescence has many good properties which electric light produced by the disruptive discharge between carbon points, commonly known as the "arc," has not.

If the electric current which produces the incandescence is quite constant, the light emitted by the white hot carbon is absolutely constant. There is not the slightest flicker or variation in it; it is, moreover, quite under control as to its brilliance, and may be made as yellow as gaslight, or as white almost as sunlight. It communicates no noxious vapors to the air, and it is not too costly.

But the crowning merit of electric light produced on the principle of incandescence is that it is indefinitely divisible without sacrifice of economy. You may have a lamp so constructed as to give a light of ten candles, or you may construct it with larger conductors so as to obtain a light of 100 candles from your incandescent carbon, and the smaller lamp will be almost as economical as the larger—light for light. That is, the ten-candle lamp will only use one-tenth of the power, and, therefore, cost one-tenth of the amount to maintain it, that is required by the lamp which gives ten times the light.

This property of divisibility into as many small centers of illumination as are required—which is inherent to this method of electric lighting by incandescence to fully the same extent as in gas light—combined with the steadiness of this species of light, its good color, and its wholesomeness, gives it a character of general applicability which is not possessed by any other kind of electric light. It is forty years since Starr, through his agent, King, took out his patent for producing light on this principle. It is only within the last two or three years that the many practical difficulties that beset the utilization of this method have been surmounted. Nothing can well be simpler than the ideal incandescent lamp. A slip of carbon in a vacuum, that is all. To realize this idea much experimentation had to be gone through and much disappointment to be suffered.

Starr did not make his lamp practical. Lodyguine, Koun, and Sawyer and Mann tried long and patiently to render it practical, but they did not quite succeed.

The first difficulty was with the vacuum. In the vacuum lamps of earlier date it was neither possible to produce nor to maintain a perfect vacuum; there were always screws and washers about them, and these, and the carbon itself in a cold state, formed a reservoir of air quite sufficient to cause the disintegration and rupture of the carbon after a few hours' ignition. Besides this difficulty of the carbon soon breaking, there was a further difficulty in the blackening of the glass inclosed.

From elaborate experiments made by M. Fontaine, and published in his work on electric lighting, the conclusion was arrived at that the blackening of the lamp bells was due to the volatilization of C. and that the breakage was also a consequence of this action, objections, if valid, quite final to the practicability of this method. In short, at the period of these experiments, four or five years ago, electric lighting by the incandescence of C in vacuo was completely discredited by the crudity of all the attempts that had been made to apply the principle, and by the fallacies which had grown out of these unsuccessful attempts, and which obtained general acceptance, so much so that in the report of the Select Committee of the House of Commons on Electric Lighting, issued June, 1879, and in connection with which evidence was given by all the highest electrical authorities of that time, there is no mention whatever even of the possibility of producing light in this way.

I saw reason for doubting the soundness of M. Fontaine's conclusions with respect to the cause of the breakage of the carbons in incandescent lamps, and years ago I proceeded to test them by experiment. My main idea was to employ in a good Sprengel pump vacuum a form of carbon made by carbonizing paper at a high temperature, with which I had experimented many years before. By means of this form of carbon I hoped to obtain economy in the light, because, as it was very thin, a small current would make a strip of it white hot.

The carrying out of my idea was made easy by the assistance I received from Mr. Stearn.

Mr. Stearn undertook to mount some of my paper carbons in a good vacuum, and after many failures from carbons breaking, he at last succeeded in making some bulbs, very highly exhausted, contain my paper carbons attached by electrically deposited copper to platinized strips which carried the current in and out of the lamp.

I had the pleasure, in February, 1879, of showing to the president of this section (Sir W. Thomson) a lamp made in this way. In making these experiments I did not confine myself exclusively to the use of paper carbon. The lamp, as constructed for me by Mr. Stearn, was extremely simple. It consisted merely of a highly exhausted glass bulb, into which were sealed, by fusion of the glass, two platinum conductors supporting the carbon.

This simple form of lamp I showed lighted at a lecture which I delivered before the Philosophical Society of Newcastle, in February, 1879. The final result of our experiments was, that when the vacuum was good the carbon did not appreciably wear away, and that when the contact between the ends of the carbon and the metallic conductors was good, the globes did not blacken. Henceforth it was possible to produce a durable electric lamp that emitted a steady light of moderate power.

Very soon after this, and I am quite sure without knowing what I was doing, Mr. Edison produced a lamp identical with mine in all essential particulars. It, too, consisted of a simple bulb, from which the air had been exhausted by the Sprengel pump, and which, like mine, had no screw-closed openings nor complications of any kind, but contained simply the in-going and out-coming wires sealed into the glass with the carbon attached to them.

Since then, the manufacture of lamps on this principle, with slight modifications in the material out of which the carbons is made, and the manner of making it, has been established on an extensive scale, both in England and America, and in the electrical exhibition now open in Paris, electric light, produced by incandescence, occupies an important position. Already in this country the method has been put to actual use in house illumination and for lighting the saloons of passenger steamers. It has also been tried experimentally in coal mines.

The success which has attended these applications is such as to render the subject one of great interest to mechanical engineers, for until that great discovery is made, of the possibility of which the President has spoken in his inaugural address, when electricity shall be produced by direct conversion of heat into electricity with smaller loss of energy than it involved in its conversion into motive power through steam—until that revolutionary change is made, we shall have to look, perhaps not entirely but mainly, to motive power, and to mechanical engineers for the apparatus wherewith to produce the electricity required for electric lighting.

REMARKABLE PROPERTIES OF PREPARED CARBON.

Here is a view of one of my lamps. Here is a bulb of glass made as nearly as possible vacuous. Here are the wires which carry the current in and out of the lamp through the carbon, which is here. The carbon is made from cotton thread treated with sulphuric acid, and then carbonized at a high temperature out of contact with air. Here is a piece of paper which has been treated by the process I have mentioned, and here is a piece of the paper before treatment. You will observe that the treatment has welded the fiber together. The difference in the carbon produced from the treated and the untreated paper is as great as the difference in the paper before carbonization. Let fall on some hard surface, this carbonized parchment paper rings like metal, while the carbonized blotting paper is soft and porous. An additional advantage of this process of parchmentization is that it facilitates the thickening of the ends of the carbon filament where good and extensive contact with the metal conductor is essential. Carbon made in this way is hard and elastic to a degree quite wonderful. Filaments 0.01 inch diameter and 2 or 3 inches long can be bent double, and on release spring back like steel. After being heated for some time to an extreme temperature by the electric current, the carbon develops qualities of hardness and incombustibility which place it in an altogether exceptional position and which give promise of great durability for incandescent lamps.

The hardening process is accompanied by a change in conductivity, the carbon in its hardened condition offering less resistance to the passage of the electric current than before. This at first sight may seem to be a disadvantage, inasmuch as the intensity of light depends on the amount of heat developed in a given mass, and this reduction in the resistance of a given filament implies a lower temperature and less light for a given current passing, but this is compensated by the less electromotive force required to overcome the resistance. To develop the same temperature and light in the extremely hard form of carbon which I have aimed at producing, more current and less E.M.F. are required, as the two are equivalent to each other. There is no loss of economy by this change of condition, and mechanically there is an advantage, for the harder C is less liable to rupture. It is, in fact, more nearly in a state of utmost consolidation and stability. The amount of light that can be obtained from one of my lamps obviously depends on the superficial area of the C, and the temperature to which it is heated, but the amount of light emitted by a hot body increases in a greater degree than the temperature. Evidently, therefore, the hotter it can be made the better for economy.

By sending enough current through the carbon its temperature can be raised to such a point as produces a light rivaling in intensity the arc light. So much as 500-candle light has been obtained from one of my small lamps when pushed to its utmost limit of endurance, but the lamps are not durable at the enormously high temperature that produces this light. The lamp that would, if pressed with current to the breaking point, give a light of 500 candles, would be durable while giving a light of 50 candles.

A very much larger return of light for power expended can be obtained if the durability of the lamp is disregarded than if durability is considered. Sir W. Thomson and Mr. Bottomley have made careful measurements of the energy expended in the production of light in my lamps. Some of their results are shown in this table, from which it appears that with one of my small lamps, when rather less than 1-6th h.p. was expended on it, a light of 42 candles was emitted, or an aggregate of 270 candles per h.p. With a higher E.M.F., and therefore a larger current, 102-candle light was obtained from the same lamp. This amount of light was produced by the expenditure of rather more than ¼ h.p., *i. e.*, the h.p. under these circumstances yielded 390 candles.

By producing light in this manner, and employing the gas engine as the motor to drive a dynamo-electric machine, the very interesting result is arrived at that more light is obtained from a given quantity of gas exploded in the gas engine than can be obtained in the usual way to produce the light directly.

An important point in this method of illumination, and one of particular interest to engineers, is the necessity for regularity of speed in the motor, unless some regulating device, such as a secondary battery, intervene between the dynamo machine and the lamps. Without such assistance the slightest irregularity in the speed of the dynamo makes itself apparent in the fluctuation in the light. The light is so sensitive to variations of speed that the overlap of a driving belt is quite sufficient to make the light wink at every passage of the joint over the pulley.

But I do not apprehend a continuance of this slight difficulty, for it is quite certain that the secondary battery, in which so great an improvement has recently been made by M. Faure, used in the manner described by Sir W. Thomson on Friday last, will come into use, to do away with it entirely, and at the same time do away with many other difficulties and inconveniences of supplying current to lamps directly from the dynamo-electric machine.

The extremely rapid alterations of direction which occur when incandescent lamps are lighted by alternating current machines do not produce any unsteadiness in the light. The lamps which have been kept lighted during several nights past in one of the picture galleries of the exhibition here, and which some of you have probably seen, are worked by Siemens' alternating current machine. You would notice they have been perfectly steady. It is a question which time alone can answer whether the lamps will prove more durable with an alternating or with a continuous current. There is, perhaps, some slight ground for surmise that they will last longer with the alternating current.

Referring back for a moment to the use of my lamps in mines. So far the mine lamp, defended by a suitable lantern, has been detached by flexible conducting wires to main conductors. The limited portability this arrangement allows is inconvenient, and the main conductors are expensive, and their retention does not permit the total elimination of the element of danger in connection with the accidental breakage of a wire. I have, therefore, thought that a completely self-contained and portable mining lamp would be an advantage, and I have here a specimen of such a lamp, for the construction of which I am indebted to the skill of M. Gimmingham. This lamp can be kept lighted for six hours by two cells of Faure's secondary battery, weighing ten pounds, and will give the light of one or two candles during that time. To charge the battery afresh it will only be necessary to place it for a time in connection with the wires of a dynamo near the pit's mouth. The lamp and its attached battery need never come out of the pit.

Now that we can look to the method of electric lighting by incandescence as a perfectly practicable method, and now that we have the means of combining the economy of the mechanical generation of electricity with the constancy and many conveniences of voltaic accumulation, it is clear that the time is now ripe for the almost unlimited application of electric light to general purposes, and that engineers may, with much advantage, give their immediate attention to the many details which fall within their province in connection with the mechanical production and distribution of electricity on a large scale.

* A paper read before the British Association, York Meeting, 1881.

THE JABLOCHKOFF SYSTEM AT THE PARIS ELECTRICAL EXHIBITION.

VISITORS to the Exhibition will at once appreciate the ease with which the Jablochkoff candle can be adapted for a variety of conditions; its simplicity in this as well as in other respects being a conspicuous advantage. A large number of brackets and pendants are shown by the Compagnie Generale d'Electricite at their principal stand located near the great lighthouse, and also at their bureau in one of the salons on the first floor. The most important parts of the holder or bracket are the copper clips, furnished with springs, which hold the candles fast and insure close contact with the copper sockets at the base of the candles. Fig. 1 shows the first system of clips employed, and Fig. 2 indicates how it has been modified. The clip is fixed to a circular base of wood, slate, marble, or onyx; two connections serve for coupling up the wires of the circuit. This type of bracket is adapted for periods of lighting not exceeding an hour and a half, and the circuit is arranged as shown in Fig. 3, where it will be seen that the current generated by the dynamo machine, M, feeds the four candles, A, B, C, D. As a rule, however, the period of lighting exceeds 1½ hours, and it is necessary generally to arrange beforehand a number of candles disposed in such a manner that in burning one after the other they last collectively for the desired period. In this manner combinations of candle holders are arranged for periods of lighting varying from 1½ to 16 hours. The special type for four candles is the one found most generally useful. Whatever may be the number of candles to be lighted one after another in order to afford a continuous light for a given time, it is necessary to employ a device by which, as soon as one candle has burnt out, the current feeding it shall be switched off to the one adjacent. This is effected either by hand, or by the use of an automatic commutator.

Two modes of arranging the circuit are used, according to whether it is desired to change all the candles upon that circuit simultaneously, or in succession. Each of these methods requires a special type of candle bracket; for the former the bracket is circular, and for the latter it is in the form of a cross.

To explain the former type we will take as an example a bracket to carry four candles, and which is illustrated by

Fig. 4. It is provided with four double clips similar to those represented in Figs. 1 and 2. These clips are equally spaced round the circular base, and below the bracket is a series of eight connections corresponding with the series of clips. In the cruciform brackets the double clips are placed at right angles, the fixed portion being on the inner side. All the four are connected by a piece of brass and are in communication with a single binding screw. The jointed portions of the clips are on the outer side and are each furnished with a single binding screw (see Fig. 5). These two classes of brackets require a four-way commutator, Fig. 6; this apparatus consists of a wooden disk around which are arranged four copper contacts, A, B, C, D, each of which has its binding screw. The central metallic stud, E, is in communication on the one side with the binding screw movable rod to the contact, No. 1, of the commutator, traverses the candles, 1, ignites them, and returns to the machine by the wire, *b d*, attached to the contact with double binding screws. In the same manner three other conducting wires are required to join up the brackets bearing the corresponding numbers on the diagram. It will be seen that if, by means of the key, the commutator rod is brought to bear successively upon the contacts, 2, 3, 4, the candles, 2, 3, 4, will be ignited. The metallic contacts of the commutator are placed so close together that the movable plate does not clear any one of them before it has come into contact with the one adjacent. By this arrangement there is never any absolute interruption to the passage of the current. With such an installation a continuous light over a period of eight hours with galvanized candles can be obtained, if at inter- with the management of the light is obliged to go from one bracket to the other, which involves a loss of time and causes a waste of carbons. With this method it is possible to extinguish one of the lights without affecting the others; for example, if it be desired to suppress light No 3, all that is necessary is to place the commutator plug in M, and the bracket will be cut out of circuit.

In some arrangements the commutator is fixed beneath the onyx or marble base of the bracket. This apparatus is technically known as a "commutator bracket," the working of which will be easily understood from the previous explanation. M. Gadot, one of the engineers of the Compagnie Generale d'Electricite, has devised an extremely simple bracket, dependent for its operation on the difference in the resistance of the lighting attachment at the end of each

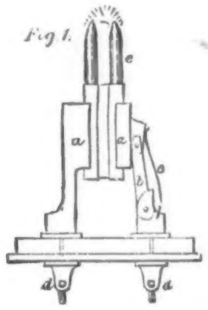


Fig 1.

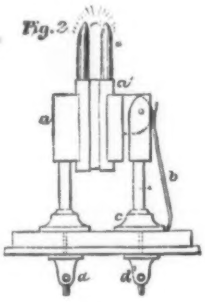


Fig. 2.

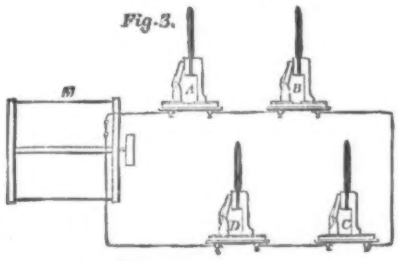


Fig. 3.

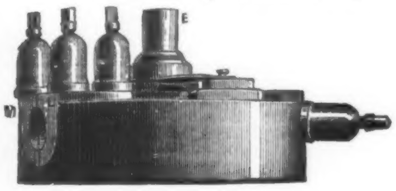
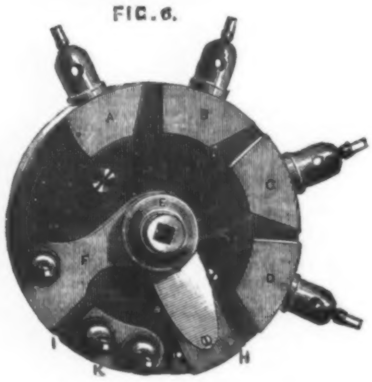


FIG. 6.



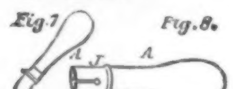


Fig. 7 Fig. 8.

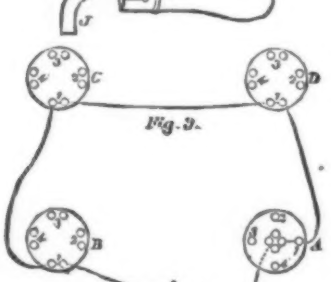


Fig. 9.

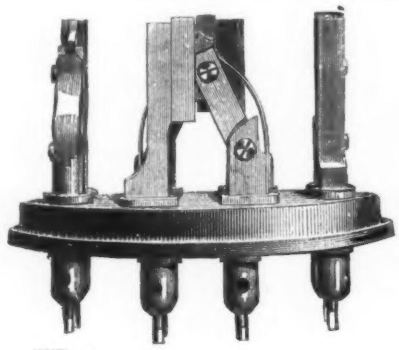
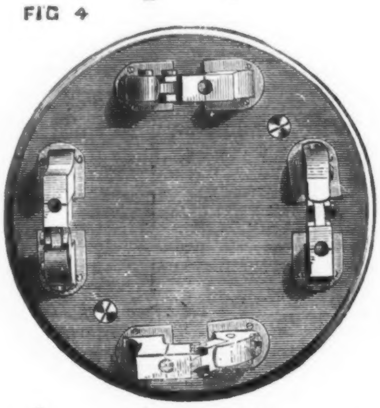


FIG 4



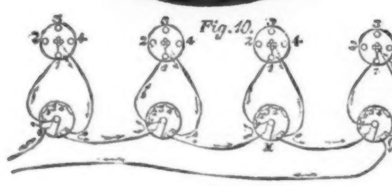


Fig. 10.

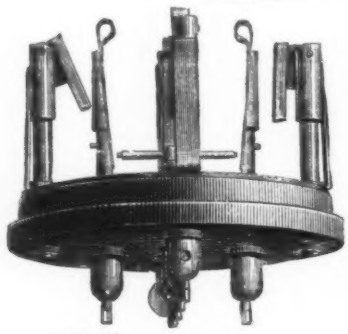
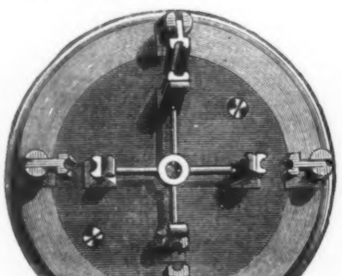


FIG. 11



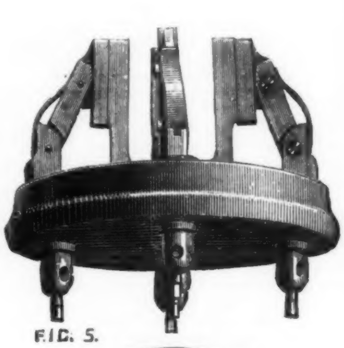
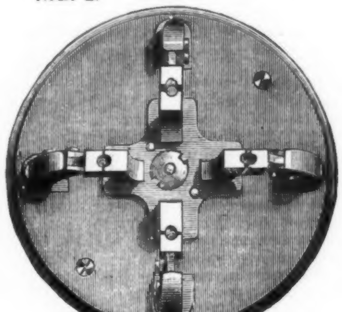


FIG. 5.



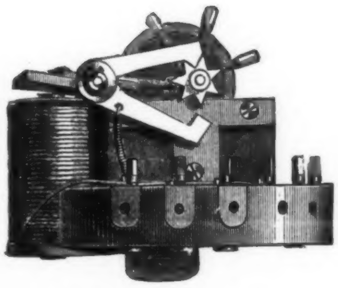


FIG. 12.

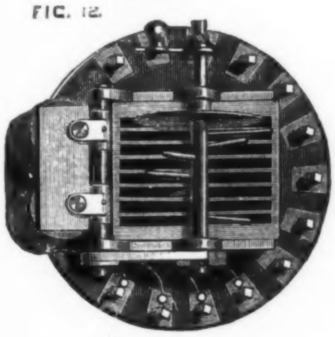



FIG. 12a.

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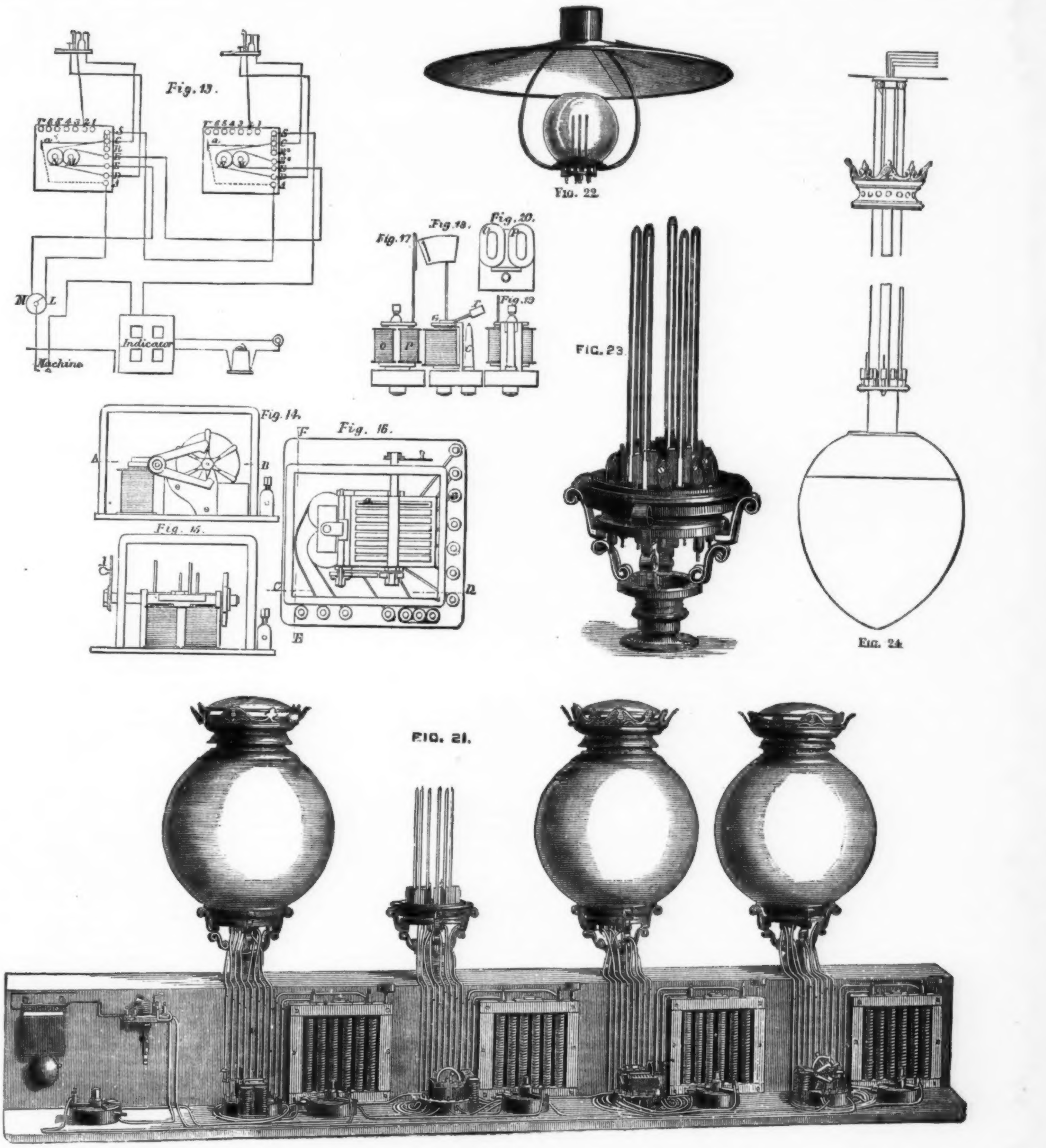
of the entering current, F, and on the other side with a movable piece, G, fitted with a steel spring; by means of a key which can be placed in the square cavity of the central stud, the movable plate can be turned successively to rest on the contacts, A, B, C, D. The contact, H, is insulated; the stud, K, which carries two binding screws, can be connected electrically with the binding screw, F, by a metallic plug, which fits into the cavity, I, between the metallic pieces, L M. The commutator key is represented by Fig 7 and the contact plug by Fig. 8. Diagrams, Figs. 9 and 10, indicate the arrangements for a circular and a cruciform circuit respectively. The installation of the circular circuit, Fig. 9, requires one cruciform bracket, A, three circular brackets, B, C, D, and one four-way commutator, E. The first conducting wire is shown by the line connecting the clips, 1, 1, 1; the current coming from the machine by *a* passes by the vals of two hours the attendant operates the four-way commutator which is placed near the electric machine. The inconvenience of the arrangement lies in the fact that it is necessary to have four circuits, 1, 2, 3, 4, between the brackets, which involve the use of a great length of conducting wire. To avoid complication the second, third, and fourth circuits are not indicated on the diagram. Fig. 10 indicates the arrangement of a circuit in which cruciform brackets are employed, and which is composed of four such brackets and of four four-way commutators placed near them. The four contacts of each commutator are connected by wires to the four binding screws of the corresponding bracket; the direction of the current is shown on the diagram by arrows, but only one circuit has been given in order to avoid complication. It will be seen that this system economizes a considerable length of wire, but, on the other hand, the attendant charged candle. The diagram Fig. 12*a* explains the arrangement. It represents four candles, 1, 2, 3, 4, placed in circuit. A is a two-way commutator by which the current can be established or interrupted; the current in passing will select that one of the four candles, the lighting fuse of which offers the least resistance, and the greater part of the current will continue to pass by that candle which will be consumed. As soon as it is almost burnt out, the circuit is interrupted by means of the commutator, and immediately restored. The interruption is sufficient to extinguish the candle, which now offers to the passage of the current a resistance higher than that of the fuses on the other candles. The current will again select that one which offers the lowest resistance, and so on until all the candles in the bracket are consumed. Ingenious and simple as this arrangement is, it offers serious difficulties in practice, which have prevented its adoption.

Among others we may mention the somewhat serious drawback of the current attempting to pass all four candles at the same time, with the result of destroying them all without obtaining any light. It might be possible previous to using them to classify the candles according to the respective resistances of their fuses; but other difficulties creep in, and a bad contact in any of the various parts of the system is sufficient to completely upset the working of the apparatus. For all that the idea has considerable merit and may some day possess a practical value.

These various methods of producing a continuous electric light require the care of an attendant to operate the commutators at comparatively short intervals, and they will be greatly simplified when candles lasting three or four hours shall take the place of those used at present, and which are consumed in half the time; but they will always possess the inherent weakness of requiring the assistance of an attendant, who may forget his duty or find himself suddenly unable to accomplish it at the critical moment. It was natural, therefore, that at an early stage of working the Jablochkoff candle, the engineers interested in its development devoted much attention to devising apparatus for shifting the candles automatically, and thereby dispensing with the services of an attendant. Several types of automatic brackets are exhibited at the Palais de l'Industrie as historical curiosities. The most primitive forms consist of a system of contacts, held back by threads, placed near the bottoms of the candles; when, by reason of combustion, the carbons are sufficiently reduced in length, the thread is burnt, and allows the contact to fall forward and pass the current to the adjacent carbons. This system was soon abandoned on account of the complication it involved with three or four candle brackets, and which, moreover, multiplied the number of contacts, and with it the chances of imperfect working. More recently another and very ingenious arrangement has been devised, and this is shown in regular operation at the Exhibition; it consists of an expansion bracket, of an automatic mercury commutator, and of an annunciator for showing the extinction of each candle.

The expansion bracket is shown in plan and elevation by Fig. 11; it is constructed on the same principle as the ordinary bracket, but in addition each clip is provided with a bent compound metal strip formed of steel and copper soldered together. When a candle is almost entirely burnt out, the voltaic arc and the incandescent portion of the carbons are brought into very close proximity to the strip, and raise its temperature. When this happens the strip, on account of the difference in the coefficient of expansion of the two metals of which it is formed, is expanded differentially, and the free end curves away from the fixed clip until it touches the contact placed in the center of the bracket. The automatic commutator consists of a hard rubber receiver divided into eight compartments containing mercury, each compartment being completely insulated from the others. The current passes to one of the outer compartments of the reservoir, and thence it is transmitted to a disk plunged in the mercury, to the spindle on which the disk is placed, and to seven arms which are fixed radially on the spindle. Each of these seven arms corresponds to one of the seven compartments, and is plunged into it in succession. Rotation is given to the spindle in order that each arm may, at the proper time, transmit the current to its compartment of the receiver, and thence to the corresponding candle. This movement is obtained by means of a toothed wheel and escapement actuated by an electro-magnet. This mercury commutator rests on a wooden base, and is inclosed in a wooden casing, on one face of which is drawn a graduated circle; an index fixed on the shaft carrying the radial arms indicates upon the circle which candle is burning. Fig. 12 shows an elevation and plan of this apparatus. The annunciator indicating the extinction of the carbons, comprises as many movable flaps, and consequently as many indicating apparatus as there are circuits in the installation. Each apparatus consists of a double electro-magnet with large wires, through which the current passes during the combustion of the candles. This electro-magnet is furnished with a movable armature, on which is fixed a rod carrying a plate divided into two parts, the one entirely blank, the other bearing the number of its corresponding circuit. A counterweight tends always to separate the armature from the electro-magnet, and at the same time to establish a contact with an insulated standard, connected with a battery and bell, in such a manner that when one of the electro-magnets is not working, the current from the battery is put into circuit with the bell.

We may now examine the installation, regulation, and working of these different apparatus. Near the dynamo-electric machine, and on the conducting wire coming from it, is placed a two-way commutator, the contact of which is connected to the contact, A, of the automatic commutator. This contact is in communication with the receiver, *a*, and consequently with the shaft and the seven arms mounted upon it (see Figs. 13 to 20). At the moment of lighting, the indicating needle, I, ought to be in a vertical position and pointing upward; the point, 1, which is plunged into the receiver to which it belongs, is itself connected to the contact 1; each of the contacts 1, 2, 3, 4, 5, 6, is connected to the fixed portion of the clips on the bracket corresponding to the first, second, third, fourth, fifth, and sixth candles; the contact for the return wire from the bracket is connected to the stud, C, of the commutator, and the expansion contact is connected to stud, D. This understood, we may observe what passes when one of the candles is nearly burnt out. The expansion strip, on becoming heated, bends, and the outer end approaches the corresponding branch of the



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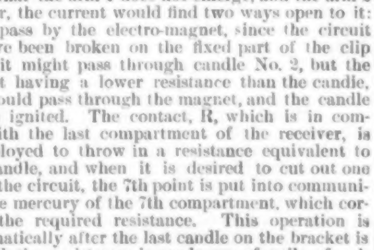
expansion star until it touches it. The current arriving by the fixed part of the clip thus finds two passages opened for it, one by way of the candle, where it encounters a high resistance, and the other by the expanding strip and the star where the resistance is much less. The greater part of the current is shunted through this latter path, passing also the stud, D, and the electro-magnet, N, quitting it at S, and going on to the contact, A, of the commutator along the ordinary return wire of the circuit. The current in passing through N magnetizes the soft iron core and attracts the armature, which communicates a rotating movement to the shaft and escapement mounted upon it, and consequently by means of the toothed wheel rotation through one-seventh of a revolution is imparted to the spindle carrying the arms. By reason of this motion the corresponding arm is lifted out of the mercury, and the arm 2 enters it; but the fixed portion of the clip 1 on the bracket being only in connection with the expansion contact, on account of the position of the expansion strip, if the current ceases to pass by this clip it also ceases to pass through the electro-magnet, and flows through the second candle on the bracket, the armature is no longer attracted, the escapement falls, and in doing so communicates a second rotating movement to the spindle carrying the arms, and the arm 2 is plunged deeper into the mercury. The same series of operations is performed with each shifting of the candles. As long as the circuit is closed, and, therefore, as long as the candle burns, the current passes through the electro-magnets, O and P, of the annunciator, attracting the armature, G, which exposes the blank portion of the indicator plate connected to it. The counterweight, I, being clear of the column, C, the circuit of the small battery is open, and the bell does not work. If, however, through the burning out of a candle, the current ceases to flow through the electro-magnets, O and P, the armature, G, is no longer attracted, that portion of the plate carrying a number is thrown into view, and the counterweight, T, falling on the column, C, closes the circuit, and sets the bell ringing. The attendant is thus informed that a candle has burnt out on circuit No. 1. He then goes to the two-way commutator on this circuit, and makes contact with the key, M, causing the current to flow through the electro-magnet, M_1, whence it passes by a special wire through the electro-magnet, M_2, of the second commutator, and then to the last commutator of the circuit, where the contact, E_2, is connected to the contact, R_2, in order to utilize the ordinary return wire. The current then passes through all the electro magnets on the circuit, the armatures of which are all attracted; the succeeding arm is plunged into the mercury, and as soon as the key of the commutator, L, is pressed, the circuit is relighted. This operation can be performed very rapidly.

The essential point in regulating the quantity of mercury in each compartment of the receiver is, that when the first point is plunged into its compartment, and the electro-magnet attracts the armature, the point 1 ought to emerge, and arm 2 to enter its corresponding compartment. When the electro-magnet ceases to attract the armature, the arm 2 should be more deeply immersed, but the arm 3 ought to remain out of contact with the mercury in its respective compartment. If there be too much mercury in the compartment 1 at the moment when the magnet attracts the armature so that the arm 1 does not emerge, and the arm 2 begins to enter, the current would find two ways open to it: 1st, it might pass by the electro-magnet, since the circuit would not have been broken on the fixed part of the clip No. 1; or 2d, it might pass through candle No. 2, but the electro-magnet having a lower resistance than the candle, the current would pass through the magnet, and the candle would not be ignited. The contact, R, which is in communication with the last compartment of the receiver, is generally employed to throw in a resistance equivalent to that of one candle, and when it is desired to cut out one bracket from the circuit, the 7th point is put into communication with the mercury of the 7th compartment, which corresponds to the required resistance. This operation is affected automatically after the last candle on the bracket is burnt out, and the resistance is made up of coils of galvanized iron wire. Fig. 21 illustrates a complete circuit with automatic brackets; it is reproduced from a photograph of one of the exhibits at the Palais de l'Industrie.

From the foregoing description it will have been seen that a group more or less numerous of Jablochkoff candles can be fixed in brackets of comparatively simple construction. These brackets are supported in the circular frame, the upper part of which is recessed to carry a globe of opal glass which is capped with a coronet and cover plate. The standard design is clearly shown in Fig. 21. A saucer of opal glass rests upon the base of the bracket; it screens the clips and serves to catch the small sparks which are produced when a candle is being lighted. A number of different varieties are shown at the Exhibition. They are arranged as candelabra on consoles or swing mountings, with the conducting wires inclosed in the supporting arm. An arrangement especially adapted for lighting workshops is shown in Fig. 24. Fig. 24 is a very effective mode of mounting.

Here the candle-holder is made so as to throw as little shadow as possible, and is fixed to a rod suspended from the ceiling; the globe, which is egg-shaped, is entirely closed below, and the coronet, which forms a finish to its upper part, serves as a balance weight, and rises when the globe is pulled down to expose the candle-holders for the renewal of the carbons.

In concluding this article, we may make reference to a special system of contacts for lights placed at a certain height, in such a manner that the apparatus can be drawn down within reach for cleaning the brackets and renewing the candles. The arrangement for distributing the current consists of two parts: the upper and fixed portion, P, Fig. 25, is furnished with a wooden support carrying at the



center a copper rod, corresponding to the return contact of the commutator. The movable portion, P', is similar in form, and carries at the center a copper sleeve, into which the fixed tube enters when the candle-holder is raised. This copper sleeve is placed into communication with the central contact of the bracket by a suitable contact; the outer clips of the bracket are placed into communication with the copper strips, $t\,t_1$, by means of contacts, and the slides, $c\,c_1$, placed around the rod, P_1, and intended to guide the strip, $t\,t_1$. When the apparatus is raised these strips enter into the slides. The rough sketch annexed explains the working of this very simple apparatus.—*Engineering.*

MAGNETO-ELECTRIC AND DYNAMO-ELECTRIC MACHINES IN THE INTERNATIONAL ELECTRICAL EXHIBITION AT PARIS.

OF all the electrical apparatus at present exhibited in the Palais de l'Industrie, at Paris, the most important are undoubtedly the dynamo-electric machines, and it is therefore only fair that my first special article should be devoted to them.

Those persons who enter the Exhibition building with the expectation of finding instruments and apparatus which are altogether new, and which have never been spoken of hitherto in scientific or technical papers, will be greatly disappointed, for there are very few things in the whole Exhibition which are conspicuous as regards novelty of construction.

Quite a different reward, however, awaits those who know how to appreciate the real object of this marvelous display of scientific instruments, and those who come here to study the gradual progress of science and the historical development of electrical apparatus may be sure that there is no place in the world where they can find better instruction or gain more reliable information.

Therefore, although my article will be chiefly dedicated to a general description of the apparatus and to the results of the experiments made with them, nevertheless I cannot forbear to make some remarks regarding the priority of invention of these apparatus, especially as I have seen with my own eyes those instruments which are types of the different classes, and felt the need of correcting opinions which are based upon prejudices, and that could only be sustained so long as there was no opportunity for a comparative study of the original apparatus which serves as a document for the history of electricity.

As the magneto-electric machines were the antecedents of the dynamo-electric machines, I will first speak of them.

The first specimen of the magneto-electric machine seems to be that of *Pixii* made in Paris in the year 1832. This machine is now on exhibition in the Retrospective Museum, Hall 18, at the Palais de l'Industrie. The powerful permanent magnet of this machine, which consists of several magnets placed together in a vertical position, is put into rotation by means of a tooth-wheel; its two poles pass closely below the two ends of the piece of iron inside of the inductor, thus creating in the wire of the latter an induction current. The coil, which is roughly wound with a very coarse wire, contrasts unfavorably with the neat, tightly-wound coils of the modern machines which now form a very important article of manufacture.

The magneto-electric machines of Clarke, in which two small induction coils are rotated before the magnet, which, being the heavier part of the machine, remains stationary, is a great step forward in the improvement of the Pixii machine. These machines of Clarke, together with those of Saxton, which are like the former, except that both the magnet and the inductor are placed in a horizontal position, are among the exhibits of many of the French and foreign manufactures.

The next in order—if we omit to mention the modifications of these machines by Stöhrer, of which there is a small specimen exhibited—are the great machines of the Society "Alliance." These latter machines, which have a great resemblance to the Clarke machines, especially in their first types, and of which a number of specimens having 2, 4, 8, 16, 20, and even 40 magnets, are exhibited in Hall 14, serve, in connection with the Wilde machines, to furnish the light for the Wilde candles. These machines of the Society "Alliance" were the first ever used for the production of electric light, and were very popular for a long time on account of being able to furnish alternate currents in a very quick succession, thus enabling the carbon points of the electric candles to burn equally and preserve the voltaic arc always in the same place. But notwithstanding the fact that comparatively good results have been obtained with these machines, and that the patent has run out, they are scarcely ever constructed any more except by the "Compagnie Parisienne d'Eclairage par l'Electricite," for the reason that the construction is complicated, and the use of steel magnets, as their magnetic power is very limited, is found unpractical for the production of currents of great strength.

An enormous improvement, however, in the electro-magnetic machines was made in the year 1857, by Dr. Werner Siemens, of Berlin, by giving to the induction coil such a shape and so placing it between the steel magnets that not only the greatest inductive power could be realized from the magnetic poles, but that the duration of time when the current is interrupted is also greatly abbreviated. This modified form of the inductor, which can be seen in the German department of the Exhibition, forms one of the peculiarities of nearly all of the Siemens machines. One of the most important applications of it is represented in the Siemens "Laute Inductor" (Bell Inductor), which is used for giving signals by means of large bells at the railroad stations; it is also largely employed in the apparatus of the Siemens block system.

The same principle forms the basis for the machines of Wilde, which, as mentioned above, are exhibited in Hall 14. These machines consist, in their most ordinary form, of two parts, and are a combination of two cylindric conductors. The upper part is nothing else but the above-mentioned machine of Siemens, consisting of a number of steel magnets; its inductor serves the purpose of magnetizing the large electro-magnet of the lower part, between the poles of which a Siemens inductor is rotating. The current produced by the strong electro-magnet in the second conductor is then utilized.

Although Wilde's machines have given excellent results in the renowned galvanoplastic works of Elkington, Birmingham, and in the large photographic studios of Woodbury and also of Saxon & Co., Manchester, where photographs were printed by means of the electric light produced by these machines, yet they are not so largely employed as formerly, as the dynamo-electric machines have become pre-eminent for this purpose. They are still employed, however, by the Society "Alliance" in France for the purpose of supplying a number of lighthouses with lights, and the system is again taken up in the Meritens machines.

A perfect revolution in electric machines took place in the year 1867, when the dynamo-electric machines were invented which supplied the place of the magneto-electric machines, rendering them almost useless on account of their inferiority of strength and also their great expense compared with the former. This invention was also due to the genius of the German electrician, Dr. Werner Siemens, whose first dynamo-electric machine, constructed in the year 1866, which is exhibited in the German department of the Palais de l'Industrie, is, undoubtedly, one of the most important instruments in the Electrical Exhibition. This apparatus exactly resembles the first specimen of the dynamo-electric machines invented by Mr. Wheatstone, of England, which is to be seen in the glass case devoted to the English exhibition in the Retrospective Museum. But the priority of invention undoubtedly belongs to Mr. Siemens, for the following reasons:

As early as December of the year 1867, Dr. Werner Siemens experimented before several physicists of Berlin with his dynamo-electric machine, furnished with one cylindric inductor and having no steel magnets, the same machine which is now on exhibition at Paris. In the middle of the month of January, 1867, he gave a lecture upon this machine before the "Berlin Academy of Sciences," which is printed in the February number of "Poggendorf's Annalen" of that same year, and which bears the following title: "*Ueber die Umwandlung von Arbeitskraft in electrischen Strom ohne Anwendung Permanenter Magnete*," *i.e.*, "On the Conversion of Dynamical Force into Electrical Force Without the Aid of Permanent Magnetism." This lecture is a decisive answer to the question of priority regarding both the discovery of the principle and the construction of the dynamo-electric machines, as all who are interested in this question will recognize by reading it.

Mr. William Siemens, of London, at the suggestion of his brother, Dr. Werner Siemens, of Berlin, had a small dynamo-electric machine constructed, and announced a lecture for the 14th of February, 1867, before the Royal Society, bearing the same title as the one given above. At nearly the same time, but immediately after Mr. Siemens' announcement, Mr. Wheatstone announced, before the same society, a lecture under the following head: "On the Augmentation of the Power of a Magnet by the Action thereon of Currents Induced by the Magnet Itself."

According to the regulations of the Royal Society lectures have to be announced fourteen days in advance by means of a circular, and the right to lecture first is given to the one who makes the first announcement. Thus it happened that the lecture of Mr. Wheatstone followed closely upon that of Mr. Siemens, and the scientists who were present at the session of the Royal Society on the 14th of February, 1867, recognized the fact that both physicists had discovered the same principles and had drawn the same conclusions. But by a comparison of both lectures it is plain to see that Mr. Wheatstone mentions nothing that had not been said six weeks before publicly by Dr. Werner Siemens in Germany.

These facts are not as well known as they should be, as will be seen by reading the works of a great French scientist, bearing the date 1880, in which he says that the ideas which Mr. Wheatstone published in a memoir read before the Royal Society on the 14th of February, 1867, were *later improved* by Mr. Siemens and Ladd, and that the merit of Mr. Siemens' improvement consists in leaving away the battery for producing the commencement current. This scientist appears to have been ignorant of the fact that Dr. Siemens was the first to discover the principle, and by making a chief point of the battery being left away, gives to the public a wrong idea of the merits of the German scientist, to whom, above all, is due the honor of having recognized the principle of the *conversion of dynamical force into electrical force* in its broadest form, and of being the first inventor of the dynamo-electric machine.

The principle of the first dynamo-electric machine may be easily understood by viewing the apparatus in the Exhibition. It consists of an electro-magnet, between the poles of which the Siemens cylindrical inductor rotates. One of the wires of this inductor is fastened to its axis, while the other is fastened to an insulated metal ring that is placed upon the axis. This metal ring is connected by means of a contact spring with one end of the coil surrounding the electro magnet, while the free end of the axis is connected in the same manner with the other end. Thus the inductor and the electro-magnet are in the same circuit, and a commutator serves for the changing of the alternative currents having the same direction. In order to prepare the machine for work it is sufficient to give to the electro-magnet a feeble magnetic polarity, which may be done by leading the current of a galvanic battery, only once before using the machine, through the spirals of the electro-magnet, but even this first magnetization is unnecessary, except in rare cases, as some magnetism resides in the iron itself.

In either case, as soon as the cylindrical inductor is put into rotation an induction current is created in the spirals of the armature, which is at first feeble, on account of the slight magnetic polarity of the iron bars; this induction current then passes through the spirals of the electro-magnet and increases the magnetism in the iron bars; this magnetism then increases the strength of the induction current, and this process is continually repeated until the induction current has reached its maximum strength, which will be the case when the iron bars of the electro-magnet are saturated with magnetism. We see from this description that the strength of the current will be dependent upon the capacity of the machine, as well as upon the amount of power applied to it. And for the reason that the principle of the machine is based upon the *conversion of dynamical force into electrical force*, it is called a *dynamo-electric machine*, in opposition to the magneto-electric machine in which the magnetism of permanent magnets is changed into electrical force.

The first dynamo-electric machine became somewhat modified in time, and one of the first modifications of it is undoubtedly that of Mr. Ladd, who shortly after constructed the first machine having two cylinders, in which one of the cylindrical inductors is used to magnetize two parallel electro-magnets, which have the shape of two iron plates, while the other cylindrical inductor supplies the current which is to be utilized for work. There are no specimens of these machines, however, on exhibition.

The first important application of the dynamo-electric principle for the production of light is seen in a machine exhibited by Messrs. Siemens & Halske, in the German department.

This machine is a combination of two machines, having a similar exterior, the smaller one appearing like a dynamo-electric machine serving to magnetize the larger one, which may be called an electro-magneto-electro machine.

These modifications were, for a long time, the only ones worth mentioning, until there appeared a new type of the greatest importance, viz., that of the so-called Gramme machines.

Of the Gramme machine, the typical particulars are: 1. An armature, having the shape of an iron ring, which forms the core of a great number of induction coils, which are connected with each other in such a manner that they may be considered as one continuous coil. 2. The commutator, or rather collector, which consists of several insulated strips of

metal forming a cylinder through which the axis passes, being also insulated from it; and 3, of two brushes which are in contact with these metal strips and by means of which the currents are collected.

But we must not forget that although machines in which these parts are contained are usually said to be of the Gramme type, yet the priority of the invention of no one of these three parts belongs properly to Mr. Gramme.

In the year 1860, Professor Pacinotti, of Italy, had already constructed a machine which contained these three parts of the Gramme machine, while it was not until the year 1871 that Jamin announced to the French Academy of Sciences that a Belgian named Gramme had constructed a new magneto-electric machine furnishing continuous currents.

The fact that to Mr. Pacinotti belongs the priority of having invented a machine similar to that of Gramme is not unknown to the public, but it is usually supposed that Gramme invented his machine without any knowledge of the principle of that of Pacinotti. To those persons, however, who visit the Italian exhibition and look at the original invention of Pacinotti, and also at the two machines later invented by him, it will be a matter of wonder how machines of two different inventors can have such a remarkable similarity, not only in regard to the principle, but also in the details of construction, and they will be forced to marvel at the freak of fate which brought such a coincidence to pass.

The employment of a collector, consisting of several insulated pieces of copper united around the axis of the armature, as seen in the Pacinotti and Gramme machines, dates still further back than 1860, and is first seen in a portion of a machine invented by Dr. Werner Siemens in the year 1853, bearing the name of "*Teller Maschine*," *i. e.*, Disk machine. The collector of this machine is exhibited in the German department, and only differs from that of the Pacinotti and Gramme collectors in the single insulated metal pieces being made to form not a cylinder, but the radii of a disk through the center of which the insulated axis passes. The currents in this machine are collected by two contact-wheels, though in his later machines Mr. Siemens employed brushes for this purpose. As soon as this latter fact became known in France the French Society that owned the patents of the Gramme machine accused the German firm of counterfeiting their invention, and Dr. Siemens, in order to avoid a long lawsuit, submitted to an arbitration, in which the French gentleman on whom the duty of decision involved decided that to Mr. Gramme belonged the priority of the use of brushes for collecting currents, and that the German firm should pay a contribution for the privilege of employing this invention.

As long as the Pacinotti machine was known only by description to the public in general, the injustice of this decision could not be recognized, but at present every visitor to the exhibition who has an opportunity to see Pacinotti's invention must be astonished at the result of this arbitration, as it is plain to see that Pacinotti employed brushes for the collection of currents many years before Gramme.

Instead of the Pacinotti ring, in the later constructed machines of the firm of Siemens & Halske, invented by Mr. Von Hefner-Alteneck, a German-silver cylinder is employed which turns round a fixed axis. The wire is wound around this cylinder parallel with the axis, in a similar manner to the Siemens armature mentioned in the beginning of this article, and avoids - being only on the outside of this cylinder—the obnoxious influences produced by the iron core becoming heated, as in the Pacinotti and Gramme machines. In later constructed Siemens machines, however, the iron core is again used for special reasons.

The visitor to the Electrical Exhibition who has studied the elements of the magneto and of the dynamo electric machines and their gradual development, will soon recognize that all the magneto and dynamo electric machines may be divided into two classes, viz., those which are modifications of the machines in which the Pacinotti ring is prominent, and which are called by the public machines of the Gramme type, and those which are modifications of the machines in which the Siemens cylindrical inductor forms the prominent part, and which are called machines of the Siemens type.

To the former type there belong, 1st, all the Gramme machines which are constructed by a great number of French and by a few foreign firms, and which, as can only be expected at a French exhibition, are the most numerous.

The magneto-electric machines of Gramme are exhibited by the "Societe Gramme" and by Messrs. Breguet, and may be seen under the northern gallery of the Exhibition building. In the same part of the building may also be found the dynamo-electric machines of Gramme, and of which the so-called type "Atelier" is the most numerous. These latter are also exhibited under the southern gallery, where a great number of them are made to furnish currents to the Gramme lamps which are suspended on both sides of the nave. Beside these Gramme machines which are constructed by Mignon & Rouert and by Messrs. Dalmau y Hijo, of Barcelona, and others, there are others found in the Belgian department constructed by Jaspar, which furnish the light for the Jaspar lamps, and under varied forms are exhibited by different manufacturers of machines. Such, for example, are the "Machines à Colonnes," the machines with flat electro-magnets, etc. Perhaps I ought also to mention four Gramme machines exhibited by Mr. Felix, of Sermaize, which have an octagonal frame and are of the same type as those which serve for the well-known experiments of the transmission of power by means of electricity, and which were used for furnishing the motor force for plowing a field at Sermaize.

The Siemens dynamo-electric machines are represented by exactly one hundred specimens, constructed by the three large houses of the firm Siemens & Halske, in Berlin, London, and Paris, and by a small number of foreign houses. The most numerous are the above mentioned machines for continuous currents, invented by Mr. Von Hefner-Alteneck, but there is also a great number of the Siemens dynamo-electric machines for alternate currents, by the same inventor.

The most important of the Siemens machines exhibited in the German department are: 1. An excellent machine which is intended to furnish a very strong light, but which, I am informed, will not be used unless there is an occasion for competition against other strong lights. 2. A dynamo-electric machine for the purpose of furnishing five differential lamps of the Siemens type. 3. A machine furnishing the light for the great candelabra in the German department, which is undoubtedly the best light in the Exhibition; these lights have the power of twelve hundred candles each, and burn very quietly. To these may be added a great many machines, which it seems are not to be used during the Exhibition. The public is especially interested in three of these machines, which are constructed for electro chemical purposes, and in which the coils of wire are replaced by magnets and thick bars of copper.

The metallic deposits produced by means of these machines are exhibited by Hutenwerwaltung, of Ocker-am-Hartz, a State mining company, which has employed these machines for a long time with great success.

Magneto-electric machines of Siemens may be seen in great numbers in the Historical Department of the German Exhibition.

Under the southern gallery of the building are exhibited the Brush machines. These machines may be said to belong to the Gramme type, in so far as a modification of the Pacinotti ring is employed, but they differ from the Gramme machine in being furnished with commutators in order to change the alternative currents into continuous currents. A large number of them are on exhibition by the Anglo-American Brush Lighting Company, and furnish the light for the Brush lamps and the Lane-Fox lamps, and three of them supply the Maxim lamps.

A very amusing scene is presented by the juxtaposition of the Maxim and Weston machines. The former being Siemens outside and Gramme inside, the other being Gramme outside and Siemens inside. It would seem here, also, as if a freak of fate had tried to play the instructor to the public.

In the Schuckert machine, the Pacinotti ring is changed into a flat ring, in consequence of which the machine is called the flat ring machine. This ring runs in a narrow magnetic field produced by four horizontal electro-magnets, the pole-pieces of which are so arranged that the principal induction of the ring is in the radial portions of the coils.

Near the Schuckert machine, and under the southern gallery, is a machine constructed by R. A. Gülcher, of Austria. His machine has also the Pacinotti ring and exteriorly resembles the Schuckert machine.

The magnetic field is produced by eight horizontal electro-magnets of oval section, arranged in two sets of fours. Between the two sets of magnets and within the pole-pieces a flat ring armature is rotated, the coils of which are wound as in the Gramme machine, but with spaces between, through which the iron wire core is exposed. The collector of this machine is of an extraordinary length, and the collecting brushes are of great width, the chances of "sparking" being thus reduced. A strange peculiarity of the machine consists in the fact that the magnet coils are wound with a double strand of copper, consisting of two thick wires twisted together.

In the *London machine* for continuous currents, exhibited near the Weston machine under the southern gallery, the Pacinotti ring is replaced by a series of electro-magnets disposed in helicoidal ranges round an axis.

Of other machines, I will mention: 1. That of M. de Meritens, which is a magneto-electric machine and exteriorly resembles the "Alliance" machine. The inductor of this machine consists of a copper ring furnished on its circumference with a number of induction coils, turning not between, but before the poles of the magnets. Six of these machines furnish the alternative currents for the lamps of Berjot in Hall 9 of the Exhibition building.

2. A machine exhibited in the United States Department, having the somewhat mysterious title of "Arago-disk-dynamo," and belonging to the proprietors of the White House Mills, Hoosac, New York. This machine resembles the Siemens machines for alternative currents very closely as far as regards the arrangement of electro-magnets. Within the magnetic field of these magnets a thin disk rotates, carrying six sector-shaped induction coils which are all wound in one direction, but are so connected that the current traversing them in series would circulate through them in opposite directions. The central space within the coils contains no magnetic cores, but is fitted up with wood. Of the six bobbins, four serve for exciting the field-magnets, while the remainder serve to supply the useful current. This method of charging the magnets necessitates the employment of two commutators and two sets of brushes, the latter being fixed upon a frame which can be rotated through a certain angular distance around the axis of the machine, as in the Maxim and Weston machines, so as to adjust the position of the brushes with respect to the magnetic field to the positions of highest efficiency.

Mr. Jablochkoff has exhibited his machine for alternating currents, furnished with a helicoidal inductor acting upon the longitudinal magnets, the efficiency of which machine is doubted by many, but it remains to be seen whether it is practical or not.

Mr. Edison has exhibited two machines which appear to be a modification of the Siemens machine, and which have a peculiar aspect on account of their electro-magnet of extraordinary length. The inductor of this machine, however, has a particular construction, and we will hereafter devote a separate article to the description of it.

In the Danish Department there stands a lonely machine, in which the inside and outside spirals of the ring-inductor are exposed at the same time to the action of electro-magnets.

Besides the above mentioned larger machines there exists a great number of smaller machines for special applications, but I will conclude this article here, and send you in another letter a description of the results of the different applications of the magneto and dynamo electric machines hitherto made at the Exhibition. GUSTAVE GLASER, Ph. D.

GAS ENGINES AT THE PARIS ELECTRICAL EXHIBITION.

THE principal exhibitor of gas engines at the Palais de l'Industrie is the Compagnie Francaise des Moteurs à Gas, of 15 Avenue de l'Opera, Paris, which shows no fewer than nine Otto gas engines, collectively of 150 horse power. The sizes of these vary from five to fifty horse-power, and they are all of them excellent examples of workmanship.

There is a new gas motor exhibited for the first time by Messrs. Thomson, Sterne & Co., of London and Glasgow, which is attracting much attention, and which appears likely to prove very successful. This is Clerk's engine, which possesses the distinctive feature of making an explosion at every revolution. The engine comprises two cylinders, one the working and the other the so-called "displacer" cylinder. The diameter of the former is 6 inches, and the stroke is 12 inches; the piston is connected to the crank in the ordinary manner, but the piston of the displacer cylinder, in which the pressure is very slight, never exceeding 5 lb. to the square inch, is driven off a pin in one of the arms of the flywheel. The pin is at right angles to the crank, and in advance of it. When the piston in the displacer advances, a combustible mixture of gas and air is drawn in during the first half of the stroke, the admission valve is then closed, and the air is admitted during the remainder of the stroke. On the return of the piston a valve is opened, making a communication between the two cylinders. At this time the piston of the driving cylinder is at the outer end of its stroke, and an annular port is opened, communicating with the exhaust pipe. Through this opening the products of combustion from the last explosion pass, the pressure in the cylinder falls, and the cylinder is ready to receive its next charge from the displacer chamber. The first portion that enters the cylinder from the displacer is the pure air that passed in after its piston had reached the half stroke, and the combustible mixture of gas and air had been cut off. This flows through the motor cylinder, washing it out as it were at each stroke, and escaping through the exhaust until the latter is closed by the piston starting on the return stroke. Meanwhile the explosive mixture has followed the pure air into the motor cylinder, and remains, as the exhaust opening has now been closed. The returning piston compresses this mixture in a space at the end of the cylinder until it is about 45 lb. pressure, when the charge is exploded, the pressure rising to some 250 lb. per square inch, and driving forward the piston to the other end of the cylinder, when the exhaust is again opened, and the exploded gases escape, leaving the cylinder free for the next charge from the displacer. This series of operations takes place at every stroke. In the engine exhibited the pressure at the end of the stroke is reduced to about 30 lb. to the inch, but in larger engines it is considerably lower, and may be as small as 5 lb. above atmospheric pressure, by means of a special expanding arrangement.

It will be noticed that a particular feature of this engine is the passing through the cylinder at each stroke a volume of pure air, which cools it down and at the same time thoroughly displaces all the residual gases from the previous stroke. To produce this result the capacity of the displacer chamber is larger than that of the driving cylinder, and the space at the end into which the explosive mixture is compressed, and as half of each charge from the displacer is pure air, the desired object of cleaning and cooling the cylinder at every stroke must be attained. In large engines this device should be of the greatest possible service, as it should effectually prevent premature firing of the explosive charge, which would otherwise sometimes occur through the existence of sparks from the ignition of particles of carbon on the side of the cylinder. The volume of air which sweeps through the cylinder at each stroke in the Clerk engine, cools it down so as to prevent the existence of sparks, or if they should be created removes them as it passes rapidly to the exhaust. The valve gear and cut-off arrangement are well designed and very simple. The mixed charge of gas and air is admitted into the displacing chamber by an automatic lifting valve, and another similar valve makes a communication between the displacer and the driving cylinder. This valve is actuated by the pressure of the air and gas in the displacer, but this pressure is very low, all that is required being sufficient to raise the valve and help to displace the residual gases left by the previous explosion in the motor cylinder. The ignition of the mixture at each stroke is effected by a small slide at the back of the engine, worked by an eccentric on the main shaft, and the same slide cuts off the supply of gas to the displacing cylinder at half stroke. The igniting device is very perfect, and as it is required to operate more frequently than in gas engines where explosions take place every second revolution, it forms also a novelty in detail. In the ignition slide is a cavity, from each end of which is a small port leading to opposite ends of the slide. At one end of the cavity is a perforated plate, through which the explosive mixture passes from the motor cylinder, communication being made by a small hole in the slide and a groove in the face of the slide, which is always in a passage in the engine face leading to the combustion chamber, at the end of the motor cylinder. After passing through this perforated plate the mixture is lighted by a Bunsen burner, the flame filling the cavity and discharging at the port in the face of the slide; the movement of this latter opens this port into a port on the side of the combustion chamber, causing ignition at each stroke. So efficient is this arrangement that it will operate successfully at a speed of 300 explosions a minute, a far higher rate than can be obtained, or is indeed required, by ordinary gas engines. Before the ignition slide is open to the combustion chamber, it is of course closed to the atmosphere; the ignition port is very small, 0·5 inch by 0·25 inch, so that a very moderate pressure keeps the slide to its face, even against the 250 lb. per square inch caused by the explosion. The slide being so small, there is no necessity for ventilating the port, as the mixture from the cylinder requires no exterior air to support its combustion. It may be mentioned that the admission valve to the displacer chamber, and that between this latter and the driving cylinder, are prevented from rattling by a very simple arrangement of hair cushion. As stated above, the engine exhibited at Paris is a small one, with a cylinder only 6 inches by 12 inches, but working at 145 revolutions it develops on the brake six horse power, and indicates about ten. The arrangement is in all respects a very promising one.

CHEAP GAS.

A very interesting exhibit in reference to gas engines is the gas-producing apparatus of Mr. A. Dowson, of Westminster. It consists of four principal parts, a steam generator, a gas producer, a purifier, and a gasholder. The steam generator is a small, square furnace, heated preferably by the gas producer. Within it is a wrought-iron coil, into the top of which water is supplied, which is converted into superheated steam before it issues through a jet at the lower end of the coil outside the furnace. This jet, drawing with it a considerable volume of air, passes into the gas producer, which is a cylindrical iron chamber, closed at the top, and lined with ganister to within a short distance of the bottom, which serves as an ash-pit, cut off from the upper part of the producer by grate-bars. Anthracite coal is fed into this producer by a hopper in the top cover, a valve being placed in the hopper to shut off the escape of gas. The mixed steam and air passes up through the burning anthracite, the steam becoming decomposed, and the oxygen from it as well as from the air unite with the carbon in the coal, and form carbon dioxide, reduced to a monoxide in rising through the body of ignited anthracite. The gas ultimately produced in the upper part of the receiver is a mixture of hydrogen, carbon monoxide, and nitrogen. This gas passes off as soon as it is formed, into the purifier, and thence to the holder, the pressure of the steam from the coil (at 25 lb. or 30 lb.) being sufficient to maintain the constant flow of gas. Anthracite is the fuel used for producing the gas, and the quantity required for this, as well as the amount of steam used, is remarkably small. To make 1,000 cubic feet of gas 12 lb. of anthracite and seven pints of water are used. By employing anthracite, only one impurity—sulphureted hydrogen—passes over in appreciable quantities with the gas, and this is easily removed by the hydrated oxide of iron in the purifier. At the Exhibition coke is employed for this pur-

pose. There is no tar nor ammonia in the gas, and no deposit of soot takes place after combustion.

COMPARATIVE COST OF RUNNING GAS AND STEAM ENGINES.

Part of the gas thus manufactured at the Palais de l'Industrie is used to drive a three horse-power Otto and Langen engine made by Messrs. Crossley, of Manchester but by far the greater part has to be wasted, as the small apparatus exhibited produces much more gas than can be used in the engine. Messrs. Crossley have we understand, devoted many months of careful trial with this gas, and are in all respects satisfied with the results obtained. A protracted series of experiments has shown the cost of manufacturing gas on this system, in an apparatus capable of producing 2,500 cubic feet an hour, to be 2¾d. per foot, including interest on capital outlay and depreciation of plant. But the efficiency of the gas is only about one-fifth that of ordinary coal gas, so that five times as much has to be employed to develop the same amount of energy; making the equivalent of 1,000 feet of coal gas amount to about 1s. 3d., and the consumption of coal for this quantity to 60 lb. Messrs. Crossley Brothers and Mr. Dowson have made, as the result of their experience, the following comparison in the cost of working a gas engine with ordinary coal gas and with the Dowson gas, for 300 working days of nine hours each, or 2,700 hours.

1. *Engine (30 Horse Power) worked with Coal Gas.*

	£	s.	d.
Consumption of gas in 30 horse-power engine is 18 feet per horse-power per hour=18×30×2,700=1,458,000 cub. feet at 3s.	218	14	0
Oil for engine, 4d. per day=4×300	5	0	0
Drivers, etc., wages 1s. per day, 1×300	15	0	0
Repairs and depreciation of engine=5 per cent. on £370	18	10	0
Interest on capital=5 per cent. on £370	18	10	0
Total	275	14	0

2. *Same Engine worked by the Dowson Gas.*

	£	s.	d.
Consumption of gas per horse-power per hour=18 cubic feet×5=90×30×2,700=7,290,000 cubic feet	39	0	0
(To make this gas 39 tons of anthracite would be employed, costing £1 per ton).			
Oil for engine, 4d. per day=4×300	5	0	0
Wages for fireman, who also tends engine, 3s. 6d. per day=3·5×300	52	10	0
Repairs and depreciation of engine 5 per cent. on £370	18	10	0
Repairs and depreciation of gas producer, 5 per cent. on £170	8	10	0
Interest on capital, 5 per cent on £540	27	0	0
Total	150	10	0

The comparison with an average 30 horse-power steam engine, assuming a consumption of 6 lb. of coal per horse-power per hour, is still more favorable, to say nothing of the fact that such an engine would consume nearly 230 tons of coal in the year against 39 tons in the Dowson gas-worked engine, a saving of over 85 per cent., while the economy as compared with the use of ordinary coal gas is, according to these figures, 45½ per cent.

Allowing for possible errors in favor of the system in the above comparison, it is evident that there exists in this arrangement a means of effecting a large economy, while in many situations coal gas is not to be obtained, and the difference of carrying 40 tons of fuel as compared with 230 is of enormous importance. In short, the arrangement appears to be one of very great promise, and to offer a means of reducing the cost in the production of power to a considerable extent.—*Engineering.*

HISTORY OF TELEGRAPHY.

THE Paris Exhibition will prove a veritable happy hunting ground to every electrician interested in the development of telegraphy. Here will be found examples of some of the oldest side by side with the most modern instruments, while the intermediate period is fully represented. As is well known the first attempts to actuate telegraphs by electricity were by means of static electricity, and it is easily understood how all such attempts must necessarily fail. Mr. A. Jones in his lectures divides into four periods the efforts made to establish electric telegraphs. First, from the development of electricity by friction to the discovery of galvanism, or the production of electricity by the chemical action of acids upon metals, in 1790 by Galvani, and by Volta in 1800. Second, from 1790 to 1830, when Oersted published his discoveries on electro-magnetism, and Ampere showed its applicability to telegraphic purposes. Third, from 1820 to 1831, when Professor Henry's discoveries on magnets and batteries were made known. Fourth, from 1831 to 1852, the date the work was published. We might, perhaps, prefer to take the third period from Oersted's work to that of Daniell, and to make a fourth and fifth period, viz., fourth from Daniell to the introduction of the telephone, and fifth from the introduction of the telephone to the present time.

In 1726 Wood discovered that the electric current could be conveyed a long distance by conducting wires. Except perhaps by means of several lectures and papers by Dr. Richardson, F R S., we fear that electricians of the modern school have never given due credit to Stephen Grey for his experimental work. No person who ever applied himself to the study of electricity was more assiduous is making experiments, or had his heart more entirely in the work. Although not directly concerned with the Paris Exhibition, we may perhaps be pardoned for referring at some length to Grey, in order to have our article a more complete *résumé* of telegraphic development. In 1729 Grey found that he could not by rubbing, etc., make metals attractive, and was led to try a glass tube 3 feet 5 in. long, and about 1·2 in. diameter. Each end was fitted with a cork to keep the dust out when the tube was not in use. His idea was to try if he could find any difference in the attraction of the tube when both ends were stopped or both open. In the course of the experiment he held a down feather near one end of the tube, and found that it would fly to the cork, being attracted and repelled by it as well as by the tube itself. He then fixed an ivory ball upon a stick of fir, about 4 in. long, when, thrusting the other end into the cork, he found that the ball attracted and repelled the feather. He then used longer sticks, pieces of brass and iron wire, and with success. A long wire being awkward to manage, he hit upon the idea of hanging the ball on a piece of pack thread and suspending it by a loop in the tube. The experiment was successful. After trying these experiments with the longest light canes and reeds he could conveniently use, he ascended a balcony 26 ft. high, and fastening a string to his tube found that the ball at the end of it would attract light bodies in the court below. He went higher, and still with successful results. But there was a limit to the height from which he could experiment, and he commenced to try the horizontal instead of the vertical. In his first trial he made a loop at each end of a piece of packthread, by means of which he suspended it, at one end, on a nail driven into a beam, the other end hanging downward. Through the loop hanging down he put the line to which his ivory ball was fastened, fixing the other end of it by a loop on his tube. After this preparation he put leaf brass under the ivory ball, and rubbed the tube, but not the least sign of attraction was perceived. Upon this he concluded that when the current came to the loop of packthread it went up the same to the beam, so that none or very little went to the ball, and he was for the time at a loss how to act. On June 30, 1729, Grey paid a visit to a friend, Mr. Wheeler, to whom he showed some of his experiments, and explained his failure. Mr. Wheeler suggested that the line to be electrified should be suspended by silk instead of packthread, and on trying the experiment the friends succeeded far beyond their expectations.

Here there was a grand discovery. Dr. Noad in his lectures, speaking of Grey, says: "It was this experimentalist that introduced the distinction between electrics and non-electrics, conductors and non-conductors." We have briefly described the experiments that led Grey to continue his researches and to ultimately make this distinction. It was on July 2, 1729, that the experiment was made in the gallery at Mr. Wheeler's house. "About 4 ft. from the end of the gallery they fastened a line across the place. The middle part of the line was silk, the rest packthread. They then laid the line to which the ivory ball was hung, by which the electric virtue was to be conveyed to it from the tube, and which was eighty feet and a half in length, across this silken line, so that the ball hung about nine feet below it. The other end of the line was by a loop fastened to the tube, which they excited at the other side of the gallery. After this preparation they put the leaf brass under the ivory ball, and upon rubbing the tube it was attracted and kept suspended for some time." (Priestley, vol. i., p. 38, 3d ed.) They wanted to try longer lengths, and so doubled the line back again along the gallery with success; they then carried the line (now 124 feet long) from the gallery to the barn with better results than when it was doubled back in the gallery. On July 3 the experiments were continued, and the silk happening to break they tried a small iron wire, but this also broke, and then they used brass wire; but the brass wire, though it supported the line very well, did not answer the purpose, for on rubbing the tube they perceived no electricity at the end of the line.

The result of the experiments convinced them that success depended upon their supporting lines being silk, and not, as they had at first imagined, upon their being small. On coming to this conclusion they continued their labor of love, and actually conveyed the current over 765 feet, nor did they perceive that the effect was sensibly diminished by the distance (*vide* Phil. Trans., vol. vii.) In August, 1729, Grey found he could obtain his results by holding the excited tube near his line, but without touching it, in fact inductively. We cannot, however, pursue Grey's investigations further. They are of exceeding interest, they are far too little known, and yet they indicate the real time when telegraphic investigation commenced.

In eight memoirs in the History of the Academy of Sciences for the years 1733, 1734, and 1737, we have descriptions of M. Du Fay's experiments and discoveries. Among other work he repeated the experiments of Grey, and observed that the experiment succeeded better when the packthread was wetted, and successfully made the experiment with 1,256 feet of line, when the wind was high, the line making eight returns, and passing through two different walks of a garden. The Abbe Nollet assisted Du Fay in most of his experiments.

Jones, in his work, speaks of Winckler as discharging a Leyden jar through a wire of considerable length, and that the river Reis formed part of the circuit. We are unable to verify this statement, as we do not know which edition of Priestley's work Mr. Jones quotes from, but there is no such statement in the third edition of Priestley. We may say that Winckler was professor of languages in the University of Leipsic, and, we believe, published several works on electrical subjects. We shall be glad if some reader acquainted with these works will describe Winckler's experiments.

In 1747, Dr. Watson was carrying out a series of experiments in order to ascertain the distance to which an electric shock could be carried and the velocity of the current. He planned and directed all the operations, and was present at every experiment. His chief assistants were Martin Folkes, Pres. R. S.; Lord Charles Cavendish, Dr. Bevis, Mr. Graham, Dr. Birch, Mr. Peter Daval, Mr. Trembley, Mr. Ellicott, Mr. Robins, and Mr. Short. The first attempt these gentlemen made was to convey the electric shock across the river Thames, making use of the water of the river for one part of the chain of communication. This they accomplished on the 16th and 18th July, 1747, by fastening a wire along Westminster Bridge. One end of the wire was connected to one coating of a charged Leyden jar, the other coating being connected to an observer who held in his other hand an iron rod, which he dipped into the river. On the opposite side of the river stood a gentleman who also in one hand held an iron rod which he dipped into the river, in the other hand a wire with which to make contact with what we may call the line wire. Upon making contact the shock was felt by the observers on both sides of the river, but more strongly by those on the same side as the machine. On the 24th July, 1747, another series of experiments was performed at Stoke Newington, in one of which the distance over which the current passed was land 800 ft., water 2,000 ft.; in the other the distance by land was 2,800 ft., by water 8,000 ft. The apparatus was arranged similarly to that at Westminster. Subsequent experiments showed that the water did not form the whole of the return circuit, but that the return circuit was partially water, partially land, and they found on repeating the experiments that it was not necessary to dip the rods into the water, as they obtained shocks when the rods were stuck into the ground. On the 14th of August, 1747, they experimented at Shooter's Hill to obtain more definite information as to the conducting power of dry ground. Only one shower of rain had fallen during the preceding five weeks. The observers were two miles apart, the insulation of the wire being obtained by carrying it all the way upon baked sticks. Further experiments were tried, but to these investigators the passage of the current, even through more than 12,000 feet of wire, appeared to be instantaneous. It is said that Dr. Watson was the first to suggest the use of electricity for telegraphic purposes.

In 1748 Benjamin Franklin, in America, set fire to spirits by an electric current sent across the Schuylkill by means of a wire, the return circuit being the river and earth. De Luc, in 1749, made a series of experiments, in which Lake Geneva formed part of the circuit. Arthur Young, in his "Travels in France," during 175 , writes of an interesting apparatus he then saw, which shows a most decided step in the progress of sending signals by electricity. He says:

"Mr. Lomond has made a remarkable discovery in electricity. You write two or three words upon paper; he takes them with him into a chamber, and turns a machine in a cylinder case, on the top of which is an electromotor, having a pretty little ball of pith of a quill suspended by a silk thread; a brass wire connects it to a similar cylinder and electromotor in a distant apartment, and his wife, on observing the movements of the corresponding ball, wrote the words which it indicated. From this it appears that he had made an alphabet of movements; and as the length of brass wire made no difference, you could correspond at a great distance, as, for example, to a besieged city, or for purposes of more importance."

In *Scott's Magazine* for 1753 is a most interesting letter signed "C. M." A copy of the work containing this letter is exhibited by Mr. Latimer Clark. This letter contained most definite proposals for applying electricity to telegraphy, but we do not hear that "C. M." (Charles Morrison, of Greenock) carried his ideas into practice. He suggested wires, equal in number to the letters of the alphabet, extended horizontally between two places. The wires were to be cemented by jeweler's cement, or fixed in glass to insulate and support them. He clearly explains the arrangement of the whole apparatus, and says: "Having set the electrical machine agoing as in ordinary experiments, suppose I am to pronounce the word *Sir*. With a piece of glass or any other *electric per se*, I strike the wire *S*, so as to bring it in contact with the barrel, then *i*, then *r*, all in the same way, and my correspondent, almost in the same instant, observes these several characters rise in order to the electrified balls at his end of the wire." Modifications in the apparatus are discussed, and altogether the letter shows a wonderful grasp of the capabilities of electricity.

In *Voigt's Magazine* (according to Turnbull) for 1794 there is a letter from Reusser, of Geneva, in which he describes an electric telegraph. "This contrivance consisted of a number of slips of tin foil fastened on a glass plate, each strip having a different letter marked on it, and connected by carefully insulated wires in glass tubes with a corresponding glass plate at a distance. Thus there was a separate wire for each letter, and one return wire for the whole series. Signals were transmitted by sending electric shocks through the different wires, and noting down the letters attached to the strips of tin foil where the sparks were observed. The attention of the observer at the distant station was drawn by firing an inflammable air pistol attached to the apparatus by means of an electric spark." Professor Boeckman improved upon this, proposing to choose as the signals the sparks passing at the distant station, using only two wires, by which first one, and then after certain intervals a grouping of sparks, would indicate certain letters. In 1795 Cavallo suggested another modification, that the firing of the pistol, or firing of pistols, should form a code for the transmission of signals. We conclude this part of our paper with another extract from Turnbull, who says:

"The Madrid *Gazette*, of 25th November, 1796, states that the Prince de la Paix having heard that M. F. Salva had read to the Academy of Sciences a memoir upon the application of electricity to telegraphing, and presented at the same time an electric telegraph of his own invention, desired to examine it; when, being delighted with the promptness and facility with which it worked, presented it before the king and court, operating it himself.

"After these experiments the Infanta Don Antonio desired another more complete telegraph, and occupied himself in testing the quantity of electricity that would be required by the telegraph at different distances, whether on land or water. Two years after the Infanta Don Antonio constructed a telegraph of great extent on a large scale, by which the young prince was informed at night of news in which he was much interested. He also invited and entertained Salva at Court. According to Humboldt, a telegraph was established in 1798 from Madrid to Aranjuez, a distance of twenty-six miles. Other writers affirm that M. Betancourt established a line of telegraph between the same places in 1787."—*Electrician.*

AIR TELETHERMOMETERS.

By E. ROUSSEAU.

THE use of telethermometers, that is to say, instruments for indicating temperatures at a distance, may, in certain applications, such as in breweries, drying kilns, conservatories, etc., be attended with great advantages. Among the apparatus capable of satisfying the conditions expected of such instruments, we may cite, in the first place, thermo electric thermometers and those whose construction is based on the variations of electrical resistance of metals heated to different temperatures.

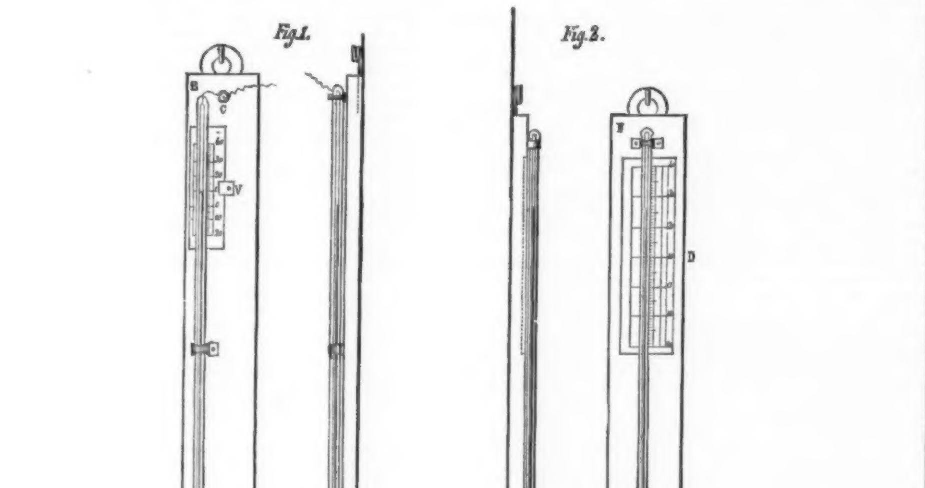
Perhaps a simpler and more practical solution of the problem of the transmission of temperatures to a distance is found in air telethermometers based on the property possessed by a gaseous mass confined within a capacity of definite dimensions of exerting, according as its temperature is more or less elevated, a greater or less pressure, which may be transmitted to a distance by means of a tube of small diameter. A telethermometer constructed on this principle is composed essentially of: (1) An air reservoir placed in the medium whose temperature it is desired to know at a distance. The nature, form, and dimension of this receptacle will depend upon the conditions under which it is to be used, upon the distance to which the indications are to be transmitted, and upon the exactness required in the measurement of the temperatures. (2) A manometric apparatus of some kind, located in the place where the temperatures are to be read off, and communicating with the air reservoir by a tube of small diameter. For this purpose an ordinary open-leg steam gauge might be used; although in such a case the indications given by the instrument would be influenced by the variations of atmospheric pressure, and these would have to be taken account of by the use of a barometer placed alongside of the manometer, thus necessitating a double reading. This inconvenience might be avoided by giving the manometric apparatus the form either of a metallic barometer, or of a mercurial barometer, the open leg of which, instead of communicating with the atmosphere,

would be connected by a narrow tube with the air reservoir, and the usual graduation of which would be replaced by a scale indicating the temperature of the air in the said reservoir. If an aneroid barometer were employed it would have to be inclosed in a box communicating with the air reservoir, and closed by a glass cover allowing of the graduation to be read through it.

It is evident that, through such an arrangement, the mass of air contained in the telethermometer would be entirely removed from the influences of atmospheric pressure, and that its pressure would be dependent only upon the temperature. We may, however, by giving the air receptacle large enough dimensions and making the communicating tube of sufficiently small diameter, render of no account the effect exerted upon the instrument's indications by the small quantity of air contained in the tube, as well as in the open leg of the barometer or in the box which contains it, if we make use of a metallic barometer.

Figures 1 and 2 represent two models of such an instrument constructed by Mr. Schubart, at my request, for the physical cabinet of the Brussels University.

In Fig. 2, the air reservoir, A, communicates by means of the tube, *tt*, with the reservoir of a mercurial barometer, EF. A thermometric scale is fixed at the upper part of the barometer tube, FF. For regulating the instrument a thermometer



ROUSSEAU'S AIR TELETHERMOMETERS. (¼ Actual Size.)

standard is employed, which permits of determining the height at which the scale shall be fixed.

In Fig 1, there is substituted for the reservoir barometer a siphon barometer, whose two legs, BC and DE, are of equal diameter and communicate with each other through the piece of drilled iron, DB. Two thermometric scales placed behind the two legs of the siphon are fixed at proper heights by means of the screws, VV. Into the two legs there are inserted two platinum rods, which communicate by means of screws, *b* and *c*, with electric alarm bells, which are set in operation whenever the platinum comes in contact with the mercury, that is to say, when the temperature descends below or rises above such limits as may be desired. To vary these limits it is only necessary to fix the easily-displaced lower platinum rod at a proper height, and to regulate the quantity of mercury in such a way that, at the temperature chosen as the extreme upper limit, the column of mercury shall reach the stationary upper rod. A screw, *a*, fixed to the piece of drilled iron, DB, sets up a communication between the mercury in the barometer and the battery which works the alarm bells.

A Large Crank Shaft.—The crank of the City of Rome, the new Inman liner, has three throws, each piece weighing about 20 tons and the whole about 61 tons, while the shaft of fluid compressed steel forged hollow will weigh 18¾ tons when finished.

A NEW METHOD OF TAKING TRANSPARENT POSITIVES.

By Captain Biny.

The inventor thus describes his method in the *Bulletin de la Societe Francaise*:

The necessary steps in this process may be shortly stated as follows: (1) Take a good negative in the camera; (2) Develop it well, and intensify it so far as may be necessary; (3) It must not be fixed; (4) Expose it on a black ground to diffused daylight, in order that the silver salts not reduced in the negative may be acted on; (5) The positive image thus produced must not be at once developed; (6) But the now useless negative must be made to disappear by means of a transforming bath—that is, the silver completely reduced by the developers which have produced the negative—must be converted into compounds of silver, insoluble in pure water, but soluble in fixing solutions, like those of hyposulphite or cyanide; (7) The latent positive image produced by the action of the diffused daylight must now be made to appear by means of a bath, which is at the same time a developer and an intensifier; (8) Lastly, this positive must be fixed by dissolving out the recombined silver salts of the original negative by means of hyposulphite or cyanide. If, in place of fixing the positive, as it is obtained after the seventh operation, it be successively treated as described under Nos. 4, 5, 6, and 7, it will be again transformed into a negative, and so on as before.

It should be here observed that, as regards the theory of this method, the principal point is the singular inaction of the transforming bath on the non-reduced salts of silver which form the whites of the negative. In fact, after the bath has destroyed all the dark parts of the negative, these salts retain completely the whole of the effect (is it physical or chemical?) impressed upon it by the action of the diffused light. At last, however, they are reduced, and then they fix the reduced silver introduced by the final developer which causes the positive to appear. The striking fact is, it may be repeated, that nitric acid, not alone, as stated by Mr. Sutton, but in combination with bromide, with chromates with chromic acid, with permanganates, or with soluble bichlorides, will, after a sufficient exposure in a good light, transform negatives into positive pictures.

This being granted, we will now examine the three following cases: 1. Positive collodion plates taken from line drawings; 2. Positive plates on collodion with half-tones; 3. Positive plates on gelatino-bromide with half-tones.

1.—PLATES COPIED FROM LINE DRAWINGS.

For this purpose a pliable collodion must be employed; it must adhere well to the glass plate, which, if necessary, may be collodionized at the edges; it must be permeable to water and to the baths, must be fluid rather than thick, and must contain both chlorides and iodides. The plate must be well exposed in the camera, so as to yield a good negative with a slight over-exposure. It must be developed with iron, but not in the first instance too strongly. It must then be thoroughly washed in water, and again developed with pyrogallic acid, at first simple, and afterwards mixed with a few drops of a highly dilute solution of silver. When this development with pyrogallic acid threatens to destroy the fine lines of the negative, its action must be stopped. The plate must then again be washed with water by means of a rose, but not too violently, so that a trace of pyrogallic acid may still be left in the permeable film of collodion. In this condition it is placed on a raised flat surface, covered with black cloth, and exposed to diffused daylight, but not to the direct light of the sun, and left there from thirty to sixty seconds, according to the intensity of the light. If the variations in tint of the negative be observed during this exposure, it will be seen that the blackened and reddish grounds will not change color, but that the bluish gray lines which have not been developed will gradually deepen in hue to a violet tone very perceptible against the deep brick-red color of the reduced silver which surrounds them. At this point the exposure must be discontinued, and the plate be taken into the dark-room, which should be illuminated through tolerably clear yellow glass panes.

Now place the plate in one or other of the following baths—

1.	Water (by volume)	500
	Pure nitric acid	300
	Saturated solution of potassium bichromate,	200
2.	Water (by volume)	500
	Pure nitric acid	300
	Pure chromic acid	20

—and watch carefully the alteration which takes place. All the reduced silver will gradually pass again into the state of nitrate, which in the presence of the bichromate or of the chromic acid gives rise to a granular deposit of chromate of silver on the white opalesque surface of the ground of the transformed negative. This chromate of silver adheres tenaciously to some parts of the plate, but principally to the old negative lines of the drawing. It has a deep brick-red color, and shows the lines of the positive image which will presently be alone developed.

In order to remove the chromate of silver which adheres to the ground of the plate, a mixture of equal parts of nitric acid, alcohol, and saturated solution of potassium bichromate, well diluted with water, should be poured over it. It is then washed, and a dilute solution of pyrogallic acid is flowed over it. After the film is thoroughly impregnated with the acid, the excess is run into a beaker, and a few drops of silver solution added to it, and this intensifier is then again poured on the plate, which has already begun to assume a positive appearance by reflection. Gradually this appearance becomes more pronounced under the action of the mixture of pyrogallic acid and silver, and the positive image will show, both by transmitted and reflected light. All the defects of the original will show, even the grain of the paper if it is the copy of a drawing or engraving; it is, therefore, important not to intensify too strongly. It may now be removed from the dark room, fixed with cyanide, and well washed. If necessary it may be still further intensified by mercury bichloride, and then by ammonia, or else again by pyrogallic acid and silver.

This process, if carried out strictly according to the instructions above given, is infallible; it sometimes gives fog in the ground parts if the original exposure has been insufficient, and particular attention must therefore be paid to this point. It is more difficult to employ it in taking portraits or landscapes, because the half-tones will be destroyed or be coated with too much silver by the action of the pyrogallic acid; but for copying line drawings it is simply perfection.

2.—PORTRAITS OR SUBJECTS IN HALF-TONES.

A very granular and permeable collodion must be again used; but for this purpose it should contain a little chloride of zinc or cadmium as well as the bromides. In taking the negative the exposure must not be too long, but still sufficient to produce all the half-tones on development. Develop with iron, and intensify to the utmost with iron and silver in the dark room. Do not wash the plate, but place it, coated as it is with iron, on a surface covered with a black cloth, and expose it to a strong diffused light. At the end of from ten to fifteen seconds, before any appreciable change has been effected in the plate, except the appearance of a slight violet tinge, take it again into the dark room, wash it, and then immerse it in the following bath:

Water (by volume)	100
Pure nitric acid	25
Saturated solution of potassium bichromate	25
	150

So soon as the negative image has disappeared, remove the plate quickly from the bath, and wash it well under a rose, from which the water is discharged with some force. By this means all the chromate of silver that could be seen on the surface is washed away, and if some by any chance still remains, pour over the plate a mixture of nitric acid, alcohol, and bichromate, which will soon clear the film.

The development with silver (very dilute) and iron must then be resumed; it must be conducted in a basin, with the greatest care, and very gradually, so that the image may come out in all its delicacy. No pyrogallic acid should be used, as that would cause the tints to be crude and rough. Finally, it must be fixed with hyposulphite, and if necessary intensified with mercury bichloride; it must then be well washed, and afterwards immersed in a 20 per cent. solution of ammonia.

3.—GELATINO-BROMIDE PLATES WITH HALF-TONES.

As regards gelatine plates which are to express the half-tones, it may be stated at the outset that all the manipulations must be conducted very slowly, and without the least sign of haste, since bromized gelatine, when moist, is infinitely less permeable by the various reagents than collodion, even of the least granular kind. The operations (of which a list is given below) must, therefore, be carried out with the greatest patience.

1. The gelatino-bromide plate is exposed in the camera for just the right length of time to get a good negative, with all the half-tones well expressed. 2 It is developed with ferrous oxalate, in a dish having a black bottom (porcelain dishes, with white bottoms, fog the plate, even in a dark-room protected with ruby glass) until the dark parts of the negative can be seen beneath the film by looking through the back of the glass plate. 3. It is then rapidly washed underneath a small tap of rain-water—that is, water con-

taining no salt of lime - in such a way as to leave much of the oxalate in the thickness of the gelatine film. 4. The plate is then placed on a flat surface covered with black cloth, and is exposed (wet as it is) to diffused light, or if preferred, to the direct rays of the sun. 5. During the exposure the variations in tint of the plate must be carefully watched. In about two or three minutes all the tints will be seen to darken perceptibly through a violet to a brick-red. At the moment when the white spots at the corners of the plate—which are, in fact, the impressions of the rests of the dark-slide—turn a deep lilac color, the action of the light should be stopped. Great attention must be paid to this point; for, if the exposure were continued longer than to produce this effect, the plate would become a mixture of negative and positive, another proof of the fact observed by M. Janssen that the salts of silver, by continued exposure, pass from the negative to the positive state, and *vice versa*. 6. Before, then, that any red tinge appears at the corners of the plate (no matter if it has dried complete during the exposure, with all its ferrous oxalate imprisoned in the gelatine), it is carried into the dark-room, and washed for a quarter of an hour in a full stream of water, so as to wash out all the oxalate. 7. When it has been thoroughly washed, the plate is immersed in the following solution:

Water (by volume)	100
Pure nitric acid	10
Saturated solution of potassium bichromate	30
Saturated solution of bromide	10
	150

Should there be any risk of the nitric acid dissolving the gelatine, as sometimes happens, five parts instead of ten parts of that substance can be used. 8. When the plate is thus immersed, the negative image gradually vanishes, and then all of a sudden the positive image makes its appearance. The back of the gelatine film is then examined, by taking up the plate by one of its corners and looking through it, and the plate must not be withdrawn from the bath until all the details of the positive image can be seen both by reflected and transmitted light. If the right moment be seized, this image will have extraordinary vigor, and be most beautifully modeled. 9. The plate is next washed in a basin for at least half an hour by means of a continuous stream of water, until every trace of bichromate—which penetrates so readily into the depths of the film, and if left there, causes spots—has entirely disappeared. 10. If this has been properly effected—and we can easily satisfy ourselves on that point by opening the door of the dark-room a very little, and letting a ray of white light fall on the plate, when no portion of it should show any signs of a canary yellow color—the positive image can be fixed by a 20 per cent. solution of hyposulphite. The image taken in this way has, in full daylight, a lilac verging on violet color, like neutral silver bromide which has been over-exposed in bright sunlight. It is beautifully soft and velvety; but, unfortunately, has not always sufficient intensity. 11. To make it more intense, it may be dipped into a bath of mercury bichloride. After it has become completely whitened, it is washed for at least a quarter of an hour, in order to remove any excess of bichloride, and then plunged into a bath of ammonia of 20 per cent. This terminates the process for the positive on gelatine.

Up to the present we have not succeeded in intensifying the rather weak tones by a mixture of silver and iron or pyrogallic acid; but it will be confessed that in the condition that we now are able to get them, these direct positives are excellently well adapted for enlargements. We hope, however, that this paper may lead some of our skilful operators to discover a powerful intensifier, by aid of which they may be able to obtain with certainty positives with half-tones softer and less harsh than those which we get by using pyrogallic acid and silver on impressions of line drawings. The latter we are taking in our own studio for the *topogravure* process, or method of printing on zinc, recently invented by M. Noë, Commandant of Engineers.

PRACTICAL HINTS ON SAVING SILVER AND GOLD WASTES.

By CHAS. COOPER & CO.

IT is a fact that only about five per cent. of the gold and silver used in producing a photograph remains on the finished picture; the balance is lost, and in giving below a few short and simple methods of saving and reducing photographic wastes and residues, we believe we confer a favor upon some of the fraternity.

Old baths and the washings of the prints should be precipitated with ordinary salt, thereby forming chloride of silver. Add the salt gradually, stirring up the solution, until it forms no longer a precipitate, which you may easily determine by taking a sample of it in a tumbler or white bottle, holding it up to the light when adding a little salt. Don't add too much, as an excess will redissolve the chloride. When the silver is all down, pour in a little acid, either nitric, sulphuric, or muriatic, which will clear the solution; allow it to stand for about twenty-four hours, then draw off your clear water, and you have the chloride on the bottom of the vessel.

The hypo or fixing solution is very rich. It should be precipitated with sulphuret of potassium previously dissolved in water, also adding it as long as it will form a precipitate. The latter, when down may be thrown on a plain muslin filter to allow the water to drain off. Such a filter may be readily constructed by taking a piece of common unbleached muslin, say a yard square, tying loops to the four corners, and hanging it up on sticks.

A good many photographers are in the habit of precipitating their washing solutions with metallic zinc expanded in sheets therein. The action of zinc, however, is slow, and must be accelerated by acidifying the solution. Now it frequently happens that the fixing solution is allowed to run into the same vessel, and, the hyposulphite being an alkali, suspends the action of the zinc. In the course of time a deposit out of the water is formed; but the happy proprietors of the "mud" are sadly disappointed in its value, as it is sometimes even so poor as not to pay for the trouble of refining.

All prints should be trimmed before toning, as it saves gold, and, besides, toned paper is of hardly any value. Keep the untoned clippings and filters clean by themselves; do not throw sweepings, pieces of glass, and spoiled ferrotype plates among them, as their bulk only decreases the real value. If you wish to burn the paper, have your stove cleared of cinders and ashes, and proceed slowly, for a good draught will carry many particles of silver through the flue.

Your toning solution throw down with sulphate of iron, but be sure and have the solution "acid," as otherwise the iron will be precipitated, and your gold goes where the "woodbine twineth." Save your developer and collodion skins; they will also amount to something in the course of time

We have likewise found that the wood of barrels which contained waste solutions for a number of years was quite impregnated with silver, some barrels yielding as much as thirty ounces of metal; so, when yours are unfit for further use, you know what to do with them.

Last, but not least, do not send small lots of waste to be refined, but wait until you have a reasonable quantity for expenses, and charges are then comparatively less.—*Philadelphia Photographer.*

ON THE SEPARATION OF HYDROCARBON OILS FROM FAT OILS.*

By ALFRED H. ALLEN, F.C.S., F.I.C.

THE extensive production of various hydrocarbon oils suitable for lubricating purposes, together with their low price, has resulted in their being largely employed for the adulteration of animal and vegetable oils. The hydrocarbons most commonly employed for such purposes are:

1. Oils produced by the distillation of *petroleum* and bituminous *shale*, having a density usually ranging between 0·870 and 0·915.

2. Oils produced by the distillation of common *rosin*, having a density of 0·965 and upwards.

3. Neutral *coal oil*, being the portion of the products of the distillation of coal tar boiling about 200° C., and freed from phenols by treatment with soda.

4. *Solid paraffin*, used for the adulteration of beeswax and spermaceti, and employed in admixture with stearic acid for making candles.

The methods for the detection of hydrocarbon oils in fat oils are based on the *density* of the sample; the lowered *flashing* and *boiling-points;* the *fluorescent characters* of the oils of the first two classes; and the *incomplete saponification* of the oil by alkalies. The *taste* of the oil and its *odor* on heating are also useful indications.

If undoubtedly fluorescent, an oil certainly contains a mixture of some hydrocarbon, but the converse is not strictly true, as the fluorescence of some varieties of mineral oil can be destroyed by chemical treatment, and in other cases fluorescence is wholly wanting. Still, by far the greater number of hydrocarbon oils employed for lubricating purposes are strongly fluorescent, and the remainder usually become so on treatment with an equal measure of strong sulphuric acid.

If strongly marked, the fluorescence of a hydrocarbon oil may be observed in presence of a very large proportion of fixed oil, but if any doubt exist the hydrocarbon oil may be isolated. As a rule, the fluorescence may be seen by holding a test-tube filled with the oil in a vertical position in front of a window, when a bluish "bloom" will be perceived on looking at the sides of the test-tube from above. A better method is to lay a glass rod, previously dipped in the oil, down on a table in front of a window, so that the oily end of the rod shall project over the edge and be seen against the dark back-ground of the floor. Another excellent plan is to make a thick streak of the oil on a piece of black marble, or glass smoked at the back, and to place the streaked surface in a horizontal point in front of and at right angles to a well-lighted window.† Examined in this manner, a very slight fluorescence is readily perceptible. If at all turbid the oil should be filtered before applying the test, as the reflection of light from minute particles is apt to be mistaken for true fluorescence. In some cases, it is desirable to dilute the oil with ether, and examine the resultant liquid for fluorescence. An exceedingly small amount of mineral oil suffices to impart a strong blue fluorescence to ether.

The quantitative analysis of mixtures of fat oils with hydrocarbon oils has, till recently, been very uncertain, the published methods professing to solve the problem being for the most part of very limited applicability; and in some cases wholly untrustworthy.

When the hydrocarbon oil in admixture happens to be of comparatively low boiling-point, it may often be driven off by exposing the sample to a temperature of about 150° C., but the estimation thus effected is generally too low, and often quite untrustworthy.

When it is merely desired to estimate approximately the proportion of hydrocarbon oil present, and not to isolate it or examine its exact character, Kœttstorfer's titration-process may be used, as suggested by Messrs. Stoddart. But the best and most accurate method of detecting hydrocarbon oils in and quantitatively separating them from fat oils is to saponify the sample, and then agitate the *aqueous solution* of the soap with ether.‡ On separating the ethereal layer and evaporating it at or below a steam heat the hydrocarbon oil is recovered in a state of purity.

Either caustic potash or soda may be employed for the saponification, but the former alkali is preferable, owing to its greater solubility in alcohol and the more fusible character of the soaps formed. A convenient proportion to work with consists of 5 grms. of the sample of oil, and 25 c.c. of a solution of caustic potash in methylated spirit, containing about 80 grms. of KHO per liter. Complete saponification may usually be effected by boiling down the mixture in a porcelain dish, with frequent stirring, until it froths strongly. In the case of butter, cod-liver oil, and other fats which undergo saponification with difficulty, it is preferable to precede this treatment by digestion of the mixture for half an hour at 100° C. in a closed bottle. After evaporating off the alcohol, the soap is dissolved in water, brought to a volume of 70 to 80 c.c., and agitated with ether. The ethereal solution is separated, washed with a little water, and carefully evaporated. The agitation with ether must be repeated several times to effect a complete extraction of the hydrocarbon oil from the soap solution.

The foregoing process has been proved to be accurate on numerous mixtures of fat oils with hydrocarbon oils. The results obtained are correct to within about 1 per cent. in all ordinary cases. In cases where extreme accuracy is desired, it is necessary to remember that most, if not all, animal and vegetable oils contain traces of matter wholly unacted on by alkalies. In certain cases, as butter and cod-liver oil, this consists largely of *cholesterin*, $C_{26}H_{44}O$.* The proportion of unsaponifiable matter soluble in ether which is naturally present in fixed oils and fats rarely exceeds 1½ per cent., and is usually much less. Sperm oil, however, constitutes an exception, yielding by the process about 40 per cent. of matter soluble in ether.† This peculiarity has no practical effect on the applicability of the process, as sperm oil, being the most valuable of commercial fixed oils, is never present without due acknowledgment of the fact. Spermaceti and the other waxes yield, after saponification, large percentages of matter to ether, and hence the process is not available for the determination of paraffin wax in admixture with these bodies, though it gives accurate results with the mixtures of paraffin and stearic acid so largely employed for making candles.

The following figures, obtained in my laboratory by the analysis of substances of known purity and of mixtures of known composition, show the accuracy of which the process is capable. The process was in each case on about 5 grms. of the sample in the manner already described.

The results are expressed in percentages.

Composition of substance taken.				Unsaponifiable Matter found.
Fat Oil.		Hydrocarbon Oil.		
Olive	40	Shale oil	60	58·03
Olive	80	Shale oil	20	19·37
Olive	40	Rosin oil	60	59·42
Olive	80	Rosin oil	20	19·61
Rape	86	Shale oil	16	15·95
Cotton seed	60	Rosin oil	40	39·74
Linseed	60	Rosin oil	40	39·32
Castor	60	Rosin oil	40	38·88
Cod-liver	70	Rosin oil	30	30·80
Cotton seed	48	Coal-tar oil	52	52·60
Lard	60	Paraffin wax	40	39·54
Lard	20	Paraffin wax	80	80·09
Olive	100	—		1·14‡
Rape	100	—		1·00‡
Castor	100	—		0·71
Cod-liver	100	—		1·82
Palm	100	—		0·54
Butter fat	100	—		0·46
Sperm	100	—		41·49
Spermaceti	100	—		49·68
Japan wax	100	—		1·14
Lard	100	—		0·23‡
Cacao butter	100	—		0·22

The following table indicates the general behavior of the constituents of complex fats, oils, and waxes when the aqueous solution of the saponified substance is shaken with ether:

Dissolved by the Ether.	Remaining in the Aqueous Liquid.	
Hydrocarbon oils: including Shale and petroleum oils. Rosin oil. Coal-tar oil. Paraffin wax and ozokerite. Vaseline.	*Fatty acids,* *Resin acids,* *Carbolic* and *Cresylic acids.*§	In combination with the alkalies used.
Neutral resins.		
Unsaponified fat or oil.	*Glycerol* (Glycerin).	
Unsaponifiable matter; as cholesterin.		
Spermyl alcohol; from sperm oil.		
Cetyl alcohol; from spermaceti.		
Myricyl alcohol; from beeswax.		

The hydrocarbon oil having been duly isolated by saponifying the sample and agitating the solution of the resultant soap with ether, its nature may be ascertained by observing its density, taste and smell, behavior with acids, etc.

I have to express my indebtedness to Mr. Charles Harrison for the valuable assistance he has rendered me in establishing the analytical facts described in the foregoing paper.

THE NEW ELEMENT ACTINIUM.

DR. PHIPSON writes us that he has succeeded in isolating the new metallic element actinium in the form of oxide and in the form of sulphide. We stated in our article last week that he would, in all probability, either isolate the new metal, or prove its non existence. The former result was obtained after a lengthened series of experiments; the oxide of the new metal was isolated in a state of purity late on Saturday night, the 3d of September, and the results of this interesting investigation were communicated to the British Association by telegram on Monday, the 5th. The oxide of actinium is white, with a tinge of salmon-color; it is very slightly soluble in caustic soda, and in this way is separated from oxide of zinc. It does not change color when exposed to the air, like oxide of manganese, nor does it appear to be affected by sunlight. It is not precipitated by ammonia from solutions containing ammoniacal salts. The sulphide, as precipitated from neutral or alkaline solutions by sulphide of ammonia, is pale canary yellow, not soluble in acetic acid, but readily so in mineral acids, even somewhat dilute. It darkens in about twenty minutes when exposed to sunlight, and then becomes quite black; this does not occur if the sulphide is protected by a piece of ordinary window glass. It is this curious actinic property that led to its discovery, and induced Dr. Phipson to call the new metal actinium.

Our readers will be able to call to mind several new metals which have been discovered through the agency of spectrum analysis, but to Dr. Phipson belongs the honor of having initiated a new method of finding the hidden treasures of the metal world. Actinium is likely to prove not merely a new element, but a novel one; that is to say, one would expect to find it very notably characteristic in its properties, and distinct from other metals. This is not always the case with new elements, rubidium and cæsium being, for ex-

* A paper read before the Chemical Section of the British Association, York Meeting, 1881.

† Either of these plans is infinitely superior to the polished tinplate usually recommended. In short, the back-ground should be black, not white.

‡ According to my experience, treatment of the *dry* soap with ether, petroleum spirit, or other solvent, is liable to cause error from solution of the soap itself, if much hydrocarbon oil be present.

* The process affords a very rapid and simple means of isolating cholesterin. Thus, on dissolving the traces of unsaponifiable matter left by butter in a little hot alcohol, and allowing the liquid to cool, abundant crystals are deposited, which may be identified as cholesterin by their microscopic and chemical characters. A sample of butterine gave no cholesterin.

† I am investigating this interesting fact, and have obtained full confirmation of Chevreul's observation that sperm oil when saponified yields a peculiar solid alcohol instead of glycerin. It is distinct from cetyl alcohol, and distills, apparently without decomposition, at a very high temperature.

‡ The experiments marked with an asterisk were not made strictly by the same process as the majority.

§ In a previous research I found that carbolic and cresylic acids were wholly removed from their ethereal solutions by agitation with caustic soda.

ample, so analogous to the previously known alkali metals as to have but little special interest attached to them.

The remarkable properties of the sulphide of actinium, especially with regard to those rays which are cut off by glass, point to a possibility of our learning much with regard to the nature of spectrum by a study of its action on sulphide of actinium; but it must of course be borne in mind that a glass prism could not be used. It is likely, however, that some other transparent medium may be employed, or diffraction gratings may, perhaps, be pressed into service.

Probably before long Dr. Phipson will be in a position to inform us as to the relative transparency of various media for those rays which affect actinium; but there is more labor involved in studying a new element than might be supposed by those who are unaccustomed to laboratory work, so results must not be expected too rapidly. The chemist upon whose shoulders a new element rests bears a burden which is by no means light.—*Photographic News.*

HOSPITAL OF ST. ELOI, AT MONTPELLIER, FRANCE.

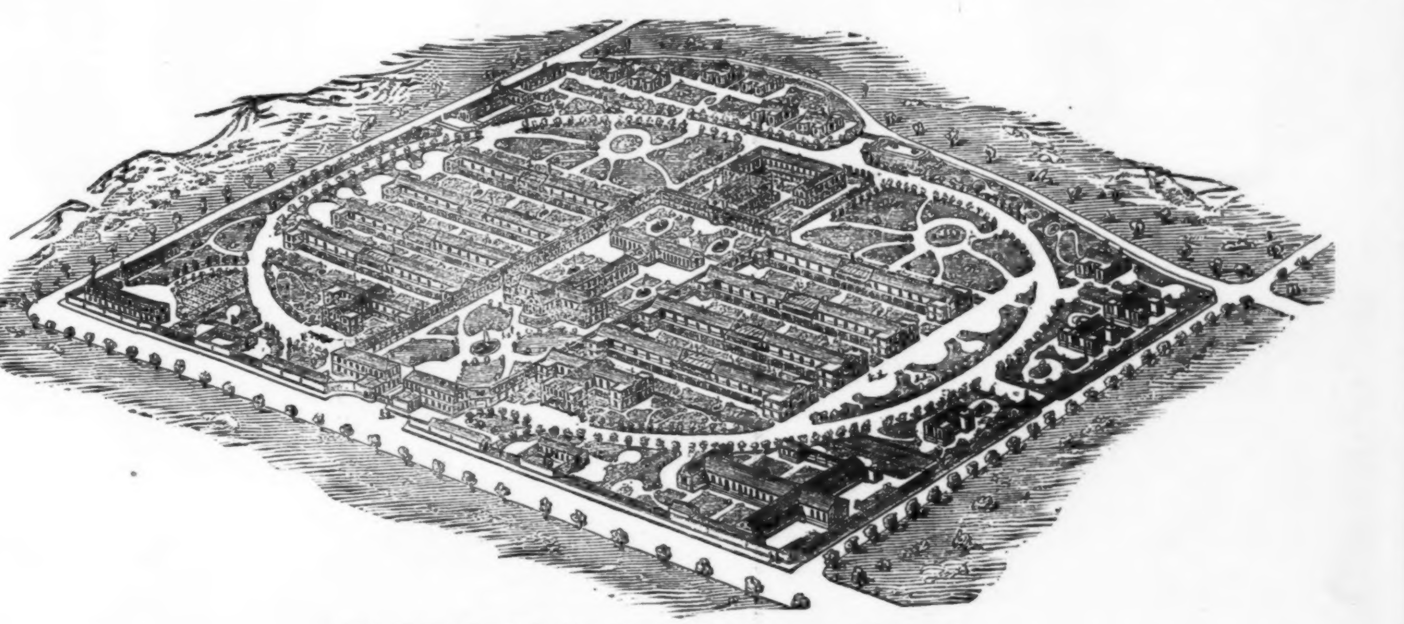
By FREDERIC J. MOUAT, M.D., F.R.C.S.

AFTER considerable discussion as to the incurable defects for the treatment of the sick, of the old hospital attached to the celebrated Medical School of Montpellier, it was determined to erect a new hospital a short way out of the town, but easily accessible from it; and the plan ultimately adopted was that of M. Tollet, upon a system which contains many features of originality, and is based mainly upon the conclusions arrived at by the most advanced authorities on the subject.

M. Tollet's system may be briefly described to be based on the subdivision of the sick into small manageable numbers, lodged in single-storied buildings, distributed over a sufficient area to prevent undue pressure upon space, and yet so connected as to be facile of access and administration. His wards are built upon the plan of the Gothic arch, to avoid all stagnation of air, or arrest of organic and other matters floating in it, by angles or corners of any kind; to be easy of heating and ventilation in winter and summer, without the adoption of expensive mechanical contrivances; to admit of the effects of the radiation of infection; it provides spare rooms, and a superabundance of aeration, eminently wholesome. The admirable statistical results of this hospital need not, therefore, excite surprise. The official reports record the signal services rendered by the separate pavilions in a serious outbreak of typhoid fever in the camp of Avron and the garrison of Bruges. Thanks to the isolation of the typhoid cases, and the hygienic measures carried out, the mortality was minimized, and none of the sick suffering from other diseases and none of the nurses and attendants were attacked."

The consecutive successful results of surgical operations were equally constant, and important proofs of the healthiness of the system of construction. The military report states that: "So far we attribute our exceptional success to hygienic conditions. We operate in conditions which may be called antiseptic. The air of the sick rooms is as pure as the external atmosphere. We must add a remarkable fact gathered from the admission registers of the hospital, that not one of the four thousand soldiers quartered in the barracks built on the Tollet system was attacked by the prevailing disease, and that all the typhoid and contagious cases came from the other barracks."

The ground on which the St. Eloi Hospital for 600 sick is to stand consists of nearly twenty-one acres, which could be increased proportionately should the number of beds be added to. The hospital is divided primarily into three distinct and independent portions, each having an entrance from without. The first consists of the main body of the hospital and its establishments, and occupies the central rectangle of the general inclosure. The second is the contagious disease department, which is placed in the salient angle of the north side; is surrounded by a belt of tall, tufted trees, and so arranged that the prevailing winds blow across it so as to carry all exhalations and emanations away from the main buildings. The third is the Maternity Department, and is divided into two departments, well separated from the rest of the buildings. That for parturition is placed in the southern angle of the great quadrilateral, and is protected by a belt of large trees, planted at the base of the general hospital, which also shelters it from the cold winds. The infirmary of this department is far away from it, and from all other buildings, on the north-east boundary of the main inclosure, as seen in the accompanying general



HOSPITAL OF ST. ELOI AT MONTPELLIER.

the provision of ample superficial and cubical space for each patient; to be constructed of materials capable of the most perfect cleansing, and to be as nearly as possible fire-proof; to be provided with verandas, to which the beds can be transferred, with little or no disturbance of the sick, in fine weather; and to have the accessories of baths, water-closets, and dependencies of all kinds so completely cut off as to be unable at any time to impair the purity of the atmosphere of the sick-room.

Provision is made in his distribution of the buildings for a careful classification of the sick and injured, and for the isolation of all infectious diseases, so that every kind and class of sickness may be effectually treated in the same inclosure, without any risk of undesirable complications, or injury either to the sick themselves or to the inhabitants in the vicinity of the hospital.

The Hospital of St. Eloi is to contain 600 beds, which may be extended to 760 in the same enceinte. It has been approved by a special commission of the professors of the Faculties of Medicine and Science, and by the Municipal Council and Hospital Commission of Montpellier, by the General Council of Civil Buildings at the Ministry of Public Works, and by the central authorities of the "Assistance Publique," in Paris. By a decree of March, 1881, it was declared to be a work of public usefulness, in exchange for the existing hospital, which is well calculated for other purposes connected with the university. The site was very carefully selected, and the buildings have been arranged in the aspect best fitted to secure the maximum of air and light. This hospital is estimated to cost £100 a bed, and if extended to a larger number would cost less. M. Tollet considers that for a hospital of 300 beds the cost would be about £108 each, and that in one of 600, with the suppression of the galleries of communication, which are not used at Friedrickshain, the cost would be a little less than £80 a bed. On this plan M. Tollet has already built large artillery barracks and a military hospital at Bourges, of which the Dean of the Faculty of Montpellier reported in November, 1880: "The hospital at Bourges, which I have just examined in all its details, consists of twelve pavilions, and the [necessary] administrative buildings, and is on the Tollet system. This system rounds off all re-entering angles, and suppresses all salient projections. It permits of the isolating of groups of diseases; it neutralizes and attenuates perspective plan. Each of the three compartments is self-contained, and has its own establishments.

The chief entrance is at the south-west end, and in front of it are regularly arranged in its center, and on two sides of a large square court, the administrative buildings and the hospital wards. The former provide amply for all the establishment, stores, and accessories necessary in so large an institution, including a chapel, stables, drying grounds, etc. On either side are the eighteen pavilions of the common hospital, divided into two distinct branches. So long as the inclosure provides for 600 patients, the superficial area for each is about 140 square meters.* At Menilmontant it is 92, and at the Friedrickshain in Berlin 133. Some of the administrative buildings are two-storied. The sick wards are all single storied, 8 meters,† or 26 feet, broad, 7·50 meters, or 22 feet 9 inches, high to the crown of the arch. Each has a veranda 9 feet 10 inches broad, with a sloping roof. All the buildings of the main hospital are connected with the pavilions by great open galleries, tramways, and telephonic communication. The contagious and maternity branches are absolutely separated. The dissecting department is as far removed as possible, in the direction of the fever quarter, and about 230 feet distant from the nearest sick ward; it is concealed by a belt of trees. The laundry and drying grounds are at an equal distance from the nearest ward. At the upper end of the central inclosure is a reservoir containing nearly 40,000 gallons of water, derived from the town supply, which will be distributed by gravitation throughout the building. This reservoir will be vaulted, surrounded by trees, and arranged as an ice house for the preservation of the ice naturally formed in winter. The supply is calculated at about twelve gallons a head daily, and proper provision is made to distribute water for drinking, cleansing, watering the grounds and gardens, and to carry off refuse or waste water. The buildings will be lighted with gas throughout.

Each separate pavilion is 170 ft. long, and 26 ft. 3 in. broad within the walls. It consists of a long room, with an annex at each end, one containing a couple of beds for isolation, a dining-room, and lavatory; the other, quarters for the attendants, medicine-room, linen-store, bath, water-closet, and dirty linen chute. In the long room are twenty-eight beds, with fourteen windows. It is 100 ft long, 26 ft. 3 in. broad, and 24 ft. high. Each patient has 98 square ft. of superficial space, and nearly 2,000 cubic ft. of air space. The beds are arranged in two rows, with an interval of 4 ft. between each.

* Each square meter is 10·76 feet.

† Each superficial meter is 39 inches, or 3 ft. 3 in.

SALIVA AND SNAKE POISON.

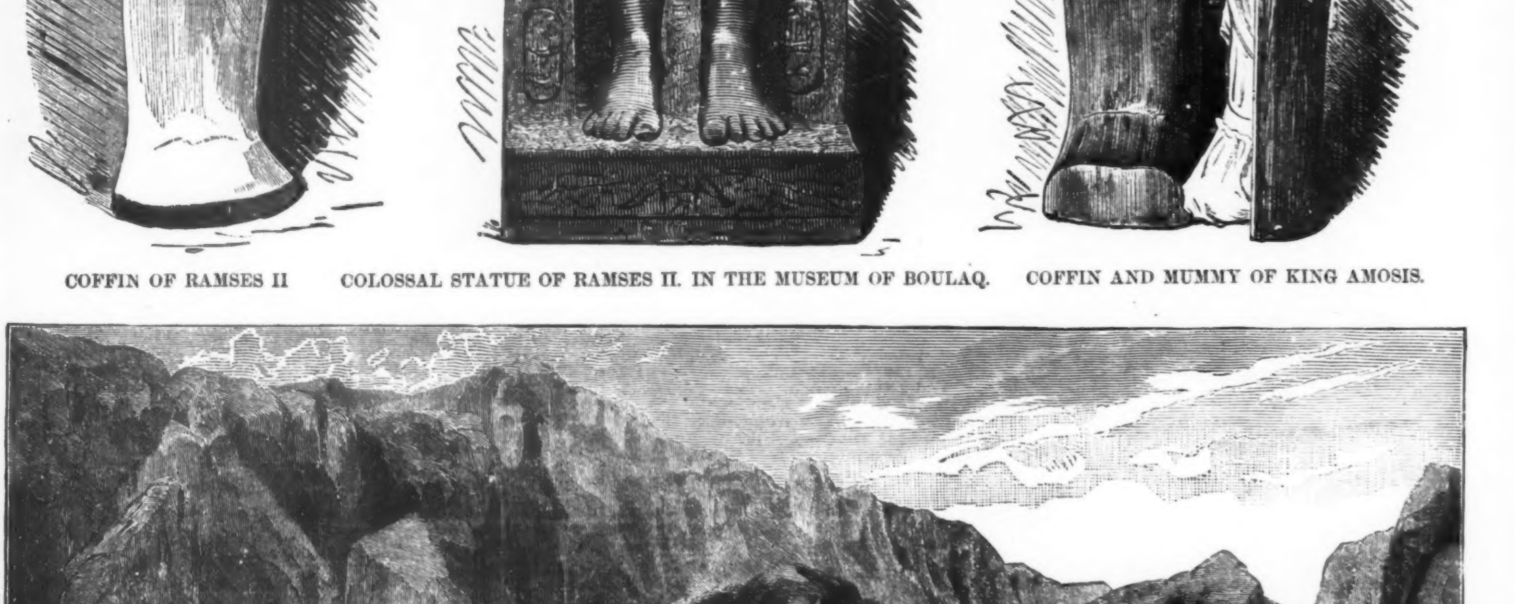
IN an age where everything is utilized, from the water-power of Niagara for electrical storage to petroleum for stimulating the growth of hair, it is not surprising that the poison of serpents should have been included in the all-embracing net of what is called practical science, and suddenly found to possess a certain useful property. According to the *Lancet*, M. Lacerda, a member of the Societe de Biologie, has just discovered that the venom of the *Lachesis rhambeata* possesses the power of digesting albuminous substances and of emulsifying fats, for all the world as though it were pancreatic juice. It certainly has no effect upon starch, but a piece of beef cut into small pieces and placed in a capsule, with distilled water and a few drops of the poison, changed with great rapidity, became softened, and finally "broken up into a greenish liquid of a peculiar odor." As for coagulated egg albumen, it was completely dissolved in twenty-four hours; while oil shaken up with diluted poison became emulsified very shortly, and was, in fact, quite digested. A number of learned conclusions have, in consequence, been drawn from these experiments. The venom of serpents is not, it is said now, a simple poison, but a pathogenic agent capable of selecting the organs and tissues upon which it can operate. Certain parts of the body appear proof against its ravages, while other parts succumb without loss of time. Another peculiarity about it is that in most instances it is but slightly affected by boiling; while on the other hand, if kept, it will give off bacteria after a certain interval. That it is not, however, an organized virus is shown in the fact that the "culture liquid," as well as the fluids which proceed from an inflammation due to the poison, cause different symptoms altogether from the poison itself, and thus inoculation from snake poison could not be conducted on the principle of vaccination from the virus of cow pox. But the most remarkable discovery of all is that it is capable of dissolving albumen, and that eventually it may prove an excellent digestive, if there be no internal lesions, and an agent of good rather than of evil.

It will be, however, a long while, we take it, before the poison of the cobra will be used instead of pancreatic emulsion for dyspeptic patients, for, notwithstanding that Dr. Stradling, of Paris, is reported to have swallowed last week, without any ill effects, five or six drops of the venom of that deadly snake after they had been placed on a lump of sugar, society for the most part would hesitate before they put an enemy into their mouth which might possibly steal away life, but an accurate knowledge of what the various poisons of serpents really are, and what they can effect, cannot but bring about good results. M. Gautier, the celebrated French savant, has just shown indeed that there is not much difference after all between human saliva and the secretions from snake fangs. Taking some twenty grammes of the salivary fluid and purifying it the other day he obtained a substance which, injected in the form of a solution under the skin of a bird, threw it into a state of coma and complete stupor, and finally killed it in half an hour. Impressed with so strange an experiment, M. Gautier went further, and found that the poisonous character of saliva was not affected even when heated to a very considerable degree, and after much careful research he came to the conclusion that, inasmuch as in its effects it greatly resembled the bite of the cobra, both as respects the period of coma, excitation, convulsions, and tetanic contraction, it is, after all, only a modified form of the venom from which we fly when the hooded Indian terror shows its teeth. Further experiments reveal the fact that the poisonous matter of saliva, when mixed with the ferrocyanide of potassium, produces, like cobra poison, a Prussian blue; and there is now reason to believe that the active principle of it is an alkaloid similar to the cadaveric poisons called ptomaines which MM. Brouardel and Boutmy have isolated. There is nothing at all unreasonable in all this. Possibly enough the poison which serpents conceal in the glands at the back of their fangs do aid them in the digestion of food, just in the same way as the human saliva is utilized by men; and as it is somewhat degrading to think that Rabelais was right after all when he claimed a poisonous property for the human bite, it is just as well that we should know precisely what it is the cobra injects into its victim, so as to be able eventually to counteract the effects.—*London Daily Telegraph.*

COFFIN OF RAMSES II

COLOSSAL STATUE OF RAMSES II. IN THE MUSEUM OF BOULAQ.

COFFIN AND MUMMY OF KING AMOSIS.



THE CAVE, NEAR THEBES, WHERE THE EGYPTIAN REMAINS WERE RECENTLY FOUND.

THE LATE DISCOVERY OF EGYPTIAN REMAINS.

THE LATE DISCOVERY OF EGYPTIAN REMAINS.

IN regard to the highly interesting mummies lately discovered at Luxor, Mr. Emil Brugsch, the discoverer, writes as follows:

As I left Siout, the Upper Egyptian main station of the Nile steamers running to Assouan, at four o'clock in the morning of July 2, of this year, I never imagined that but few hours separated me from a moment in my life as but few mortals are favored with, and the remembrance of which will for ever remain fresh in my memory even to my oldest days.

In the afternoon of the fourth of July I arrived at Luxor, to begin the exploration of the newly discovered treasures the next morning. When and how this place, which was kept secret for years by the Arabs, was discovered, can only be of interest to those thoroughly acquainted with the country, its inhabitants, and other circumstances connected therewith. It will be sufficient to state that for nine years several small and more or less valuable antiquities, which were secretly sold at Thebes, led to the belief of the existence of a royal grave from which these antiquities were taken, but all efforts to discover this grave or graves were in vain. During the inspection tour which I made last April with Mr. Maspero, the director of the Egyptian Museum at Boulaq, and successor of Mariette, I succeeded in finding the main accessary of the secret, but could get no information in regard to the location of the grave. Only two months later several circumstances led to the discovery of the grave or hiding place, the exploration of which I was to undertake shortly. The ruin known by the modern name "Der-el-Bahri," and located on the western shore at Thebes, is known to all travelers. The same rests against the steep hills which separate it from the royal graves, and which hills form a grand terminus for the old palatial temples built by Queen Hatasou (18th Dynasty). The hills run in a southwesterly direction far beyond the ruins of Medinet Habou. About 160 yards from Der-el Bahri, and almost exactly behind the ridge of the hill Sheik Abd-el Gournah, which is almost literally covered with graves, a narrow, natural path leads to a small ravine or pass, about 200 feet above the Theban plain, but hid entirely by projecting and jutting lime stocks, rocks, and bowlders, and at this point I had to enter the sepulchral chamber. At my disposal I had three hundred Arabs and a somewhat primitive supply of ropes, beams (*i. e.*, trunks of trees), and pulleys, required to enter the shaft, which is about 46 feet deep. I placed one foot in the noose of a rope and held myself on another rope, and in this way entered on my subterranean trip, which terminated rapidly and safely. The square shaft, measuring six feet on each side, was hewn roughly and carelessly into the rocks, so that overhanging and jutting ledges and projections were formed which crumbled and tumbled down as soon as touched. It seemed as if the shaft had been made in the greatest haste. At the bottom of the shaft I found an entrance way 5 feet 1·5 inches wide and 36·5 inches high, which led straight ahead for a distance of about 25 feet. The air, which had been inclosed for over two thousand years, was so poor that my lamps could not illuminate the objects in my most immediate neighborhood.

I had to grope and feel more than see what was ahead, or rather below me, for the entire passage was filled with coffins, boxes, statuettes, and articles of every kind, to such an extent that I had to creep over them.

Upon arriving at the end of the passage, 25 feet in length, I was of the opinion that I had reached the end of the subterranean hall, when I suddenly discovered that the same continued to the right and in a northeasterly direction, at a length of about sixty yards and a varying height of from about two to four yards, every inch of the floor being covered with coffins and antiquities of every kind. My astonishment and bewilderment were so great and overpowering that I hardly knew whether I was awake or whether this was only a dream. I seated myself on a coffin to recover from the enormous excitement, and glanced at the lids of the various coffins, and clearly and distinctly saw the name of King Seti I., the father of Ramses II., both of the nineteenth dynasty. A few steps further on, in a plain wooden coffin, and with his hands crossed on his breast, lay Ramses II. himself. The further I advanced all the greater and grander were the riches that appeared before me. Here Amenophis I., there Amosis, the three Thothmes, the Queen Aahmes-nofert-ari, the Queen Aah hotep, all the mummies being perfectly preserved—altogether, thirty-six coffins of kings, their wives, princes, and princesses. I had to spend two hours in the subterranean passage to form an approximate estimate of all the riches before me.

As soon as I regained the surface of the earth I began to make preparations to raise the coffins, a task connected with enormous difficulties, especially as the temperature was from 32° to 34° Reaumur (104° to 108½° F.) in the shade. Four days later all the well conserved Pharaohs were on the eastern shore at Thebes, and three days later the steamer of our museum, for which I had telegraphed, arrived at Luxor. The sacred stream probably never carried greater and nobler freight. At present the royal corpses are in the Museum of Boulaq, the rooms of which are too small to receive all these treasures in a proper and becoming manner.

An exact and carefully prepared classification of the articles and mummies found will require a long time. The main results are as follows: Four papyrus rolls, seven mummies of kings, nine of queens, and a number of mummies of princes, princesses, and members of the royal court. They are: Of the Seventeenth Dynasty, 1. King Taaten Raskenen; of the Eighteenth Dynasty, 2. King Amosis, 3. Queen Aahmes-nofert ari, 4. Queen Aah-hotep, 5. King Amenophis I., 6. Thothmes I., 7. Thothmes II., 8. Thothmes III., 9. Prince Sa-Ammon, 10. Princess Sat-Ammon, 11. Princess Merit-Ammon, 12. Queen Hout-tamehu, 13. Princess Mes-hout tamehu, 14. Queen Setka, 15. Queen An, 16. Priest Nebseni; Nineteenth Dynasty, 17. King Ramses I., 18. King Seti I., 19. King Ramses II.; Twenty-first Dynasty, 20. Pinotem, Grand Priest, 21 Queen Nedjemt, 22. Queen Ramaka, and her daughter Mutem-hat, 23. King Pinotem, 24. Queen Hathor-houtatni, 25. High Priest Masaherta, 26. Princess Ast-em-cheb, 27. Princess Nesi-chonsu, 28. Prince Djet-ptah-anf-anch, and others.

Further a large tent made of leather in red, green, yellow, and white, for the Princess Ast-em-cheb, daughter of King Pinotem, for the decoration of her grave. Further, 40 canopies, among them 4 belonging to the mummy of Queen Aahmes-nofert ari; 3,700 Osiris statuettes, 12 to 15 large ceremonial whigs, 46 wooden chests, with inscriptions, several chests made of papyrus and containing articles of sacrifice, such as ducks, meat, etc.; 4 bronze chairs, with libation vases, provided with names of Princess Ast-em-cheb; a large wooden tablet with hieratic text, and a large number of smaller articles.

All the mummies, almost without exception, are in a perfect state of conservation, some even to such extent that it appears as if the wrappings had only been completed the day before. All are covered, more or less, with wreaths and lotos flowers, the colors of which are preserved most wonderfully. When Belzoni discovered the grave of Seti I., in the valley of Biban-el-Moluk (Thebes) a few years ago he found the same in good condition, but the stone sarcophagus, at present in England, was empty. The fifth coffin I found was that of Seti I., with the well preserved body of the king. The entire place was destined by the Pharaohs (probably the priests of Ammon of the Twenty-first Dynasty) as a hiding-place for the mummies of their ancestors, in case of a revolution or an invasion. This is at least indicated by inscriptions, and the hurried manner in which the covers and passages are made. For almost three thousand years the old Pharaohs have rested here, until I have had the rare fortune of bringing them to daylight and thus making them and the other objects accessible to science. —*Illustrirte Zeitung.*

THE RECENT DISCOVERIES IN EGYPT.

THE following extracts from a letter received from Mr. Alexander Peake, who holds the office of Inspector of Provinces in Upper Egypt under the "Contrôle Générale," have been published in the London *Times:*

CAIRO, August 31.

All those who take an interest in the past life of this country have been awaiting with the utmost anxiety the arrival from Upper Egypt of the proofs of the reported grand discovery made lately, and which Herr E. Brugsch has gone to bring home to Cairo, said to consist of various kings and queens who have long been known by name, but have scarcely been thought to exist longer in the state in which they are well known to have been preserved after their death. The remarkable and valuable things found much more than substantiate the reports, but before entering into a description of the actual relics found, and now lying in the Boulaq Museum, it may interest you to have a short account of how the valuable mummies, cases, etc., were found and rescued from their tombs.

It was remarked by the authorities of Upper Egypt during the earlier part of the year that an unusual quantity of antiquities, papyri, statues, pieces of mummy cases, etc., were offered for sale by the natives. A suspicion was caused by this fact, and the matter reported to the Viceroy, who sent Herr E. Brugsch to Upper Egypt to investigate and endeavor to find out the reason. His investigations soon proved to his satisfaction the fact that more was known of the valued treasure than should be confined to the sole keeping of such people as the natives, whose only reverence for the antiquities is in exact proportion to the amount of sovereigns or piasters they can secure in exchange. More careful and systematic investigation very soon enabled Herr Brugsch to discover the native who was in possession of the desired secret, and he was called to give an account of all he knew. To all those knowing the country it is needless to remark the native was entirely ignorant of any tomb or valuable. However, he was given six hours to make up his mind and receive the reward for disclosing his secret. Fair means failing, and the six hours having passed without the man presenting himself, an order was issued for his arrest, and as he still pleaded ignorance he was put into prison. Meanwhile the fact traveled to his brother, with whom he had had a quarrel, and, it being a fine opportunity for revenge, he disclosed the whole secret, and conducted Herr Brugsch to the tomb, in which were such treasures as never yet have been discovered, and one cannot but regret that the late Mariette Pasha is not alive to participate in the wonders which it is now the good fortune of M. G. Maspero to be the medium of giving to the world. At Der-el-Babari, or the Northern Convent, in the Libyan mountains, was the pit or tomb, about thirty feet deep, cut into the solid rock, and leading into a gallery about one hundred and fifty feet long, and full of the most perfect antiquities yet exhumed. For several minutes Herr Brugsch remained in silent awe, overpowered by the grand sight of the splendid wonders, unable to do anything but gaze at the magnificent cases containing the mummies of Egypt's past kings and queens, with papyri, statues, etc. Steps were at once taken to remove all to Cairo, and a steamer was a few days afterward on its way with the whole collection bound for the museum, where everything now is. Such is the history of the discoveries, and I should like to describe in detail all there is to see. But this must be left to those more competent than myself, and from whom you will get a historical account. A few, however, of the most important things may be interesting, which will give you an idea of the great value of this discovery. Through the kindness of a friend I had the pleasure of visiting the museum, and the most interesting of many interesting objects, to an ordinary visitor, are its various and numerous cases containing the mummies of ancient Egyptians and over twenty-five royal personages. English people will generally feel more deeply the value of these discoveries when it is known that among the royal mummies are to be found the embalmed bodies of the King Thothmes III., about B.C. 1600, and King Ramses II., about B.C. 1330. The former it was who ordered the execution of the obelisk which now ornaments the Thames Embankment, and the latter who, two hundred and seventy years later, added his own titles to those already inscribed by order of his predecessor, Thothmes III. It is difficult to realize the fact that, side by side in the Boulaq Museum, one can now see the actual bodies, inclosed in their respective cases, of men whose orders caused the execution of the monument so lately the object of so much interest in England, and which in almost perfect preservation has survived three thousand years. It is curious to note in these cases containing the royal mummies the flowers (among the number the now obsolete lotus), and garlands with which it was the custom to encircle the neck of the embalmed body after swathing with cloth, perfect in form, but perhaps not unnaturally faded and dry. It is supposed that these royal mummies were removed from their own tombs and sarcophagi to prevent their being desecrated by an invador, perhaps Cambyses, and placed for safety in the pit just discovered. This would seem to be corroborated by the fact that Belzoni found and took away to England a sarcophagus, but without any mummy, some years ago, and that the body for which that same sarcophagus was made, and said to contain at one time, is now found among the number collected in the Der-el-Babari, and now lying at Boulak side by side with the supposed father of Ramses II., during whose reign, it is said, Moses was born (somewhere about the sixth year). One of the most magnificent of the mummy cases is that containing the body of King Ramses' daughter (possibly the identical lady who found Moses in the cradle among the bulrushes), which is in a most perfect state of preservation, looking, as it lies in its coffin, just as if it had only a few hours previously left the hands of the people whose duty it was to embalm and swathe it in its cloth. The coffin is most beautifully finished and ornamented with colors and a sort of mosaic of precious stones. The colors are as fresh as though only done yesterday. It is to be regretted that much of the valuable mosaic has been robbed, having been chipped off, evidently with some sharp instrument. The crystal eyes have also been removed, but the breast ornamentations fortunately remain perfect and untouched, thus giving one an idea of the grandeur of this case before its mutilation. If all the wives and children of this distinguished monarch were treated in the same fashion as this daughter, one may hope to some day find other specimens of this grandeur, for he is said to have had many wives and one hundred and seventy children. It was during his son's reign (his successor) that the plagues of Egypt occurred and the Exodus of the Israelites.

Every one will await with impatience the translation of the various papyri, which form anything but the least important portion of this discovery, and may possibly prove its most valuable feature, as throwing conclusive light upon many points which are now much disputed among *savants* of Egyptology. Many alabaster vases were also found, which are said to contain the heart, etc., of defunct kings and queens, etc. Small statues in many hundreds have also been added to the already large stock in the museum; also a most curious tent made of pieces of leather of different colors sewn together, and bearing the cartouche of some king and hieroglyphs embroidered in various colors. It is supposed to have formed a canopy over the sarcophagus of some king or queen. Another curious feature in this collection from the Der-el-Babari is a number of hair wigs, the property of royal personages, who upon occasions of grand ceremony thus adorned themselves.

There are many other things of great interest, but you will see from the foregoing how valuable and grand has been and is this collection, the full value of which, however, we must wait until a thorough study has been made by M. G. Maspero and others to thoroughly understand. The papyri read and translated, the mummies, perhaps, unwrapped, and all told which can be by those documents and defunct personages of a far-off past, will afford an interesting subject for some future time.

INFLUENCE OF FORESTS ON WATER COURSES.*

By DAVID D. THOMPSON, of Cincinnati, Ohio.

THE rapid destruction of our forests has at last begun to attract public attention, and the efforts of those who are endeavoring to awaken interest in the preservation of the standing trees, and to promote their cultivation where none exist, are bearing fruit, especially in the prairie States of the West and North-west. The arguments used are usually such as may be embraced in the question: What shall we do for fuel, for fences, for ships, for building material, for railroad ties, and for the innumerable industries of which wood forms a part, when our forests have entirely disappeared? For all these purposes it is probable that some substitute may be found. But there are other uses for our forest trees, and for which nothing else can take their place. Important, possibly most important, among these is the influence of forests, and the effect of their removal upon water courses, such as lakes, rivers, creeks, and brooks, and also upon springs and wells.

Trees during a rain-storm retain a vast quantity of water. Fantrat found that the soil covered with forests received six-tenths of the whole rain-fall, the trees having intercepted four-tenths. The proportion, however, will vary, depending largely upon the character of the foliage and the nearness of the trees to each other.

Besides what is retained by the branches and leaves, the roots, by keeping the soil around them loosened, induce the speedy absorption of the larger part of the rain which reaches the ground, and much of which, but for the trees and their effect upon the soil, would immediately flow away. The foliage of the trees, by partially or wholly excluding the sun's rays, prevents, in large degree, the evaporation of the water in the soil, which in a treeless region soon renders the ground as destitute of moisture as though no rain had fallen.

By the absorption of the rain as it falls, the flooding of the streams is largely prevented; and by retaining the water in this natural reservoir, and allowing it to flow off gradually, the trees are supplied with water continuously. It can safely be said that no stream having its source near a tract of forest has ever ceased to flow.

In the early history of the Eastern and Middle States, a farm was regarded as lacking in an essential feature if there was no spring upon it, and the farmer's wife would as much expect to do without milk-pans as to do without a spring-house. But now a spring-house is a rare sight. When the pioneers settled these lands, they were covered with forests, and the first and most important work of the new settler was to cut away the timber, in order to get land upon which to raise food for himself and family. For many years there was, of course, no apparent effect upon the water-courses; but as the number of settlers increased and the amount of forest land decreased, the springs began to dry up, and with them the brooks and creeks and smaller rivers.

It is not unusual to find in many localities the beds of what were once important mill-streams waterless, except when filled by sudden freshets; and in this State (Ohio) certain streams emptying into the lake, which were once declared navigable, will not now float a canoe. Previous to 1832 a Captain Delorac, of Hamilton, Ohio, annually sent a fleet of flatboats down the Big Miami River, at the Spring rise; but with the destruction of the forests along that river, the rise became so uncertain that the enterprise was of necessity abandoned. Professor Newberry, in his Geology of Ohio, states that the Ohio River has been getting lower and lower, in dry seasons, for many years. About 1871–1872 the Ohio sank lower than had been known before, and at Smith's Ferry, where the Pennsylvania line crosses, a ledge of rocks was laid bare that had not been seen or heard of by any people living in that vicinity.

Lapham says that, "such have been the changes in the flow of the Milwaukee River, even while the area from which it receives its supply is but partially cleared, the proprietors of most of the mills and factories have found it necessary to resort to the use of steam, at a largely increased yearly cost, to supply the deficiency of water-power in dry

* A paper read at the Cincinnati Meeting of the American Association for the Advancement of Science, August, 1881.

seasons of the year. The floods of spring are increased until they are sufficient to carry away bridges and dams before deemed secure against their ravages. What has happened to the Milwaukee River has happened to all other water-courses in the State from whose banks the forests have been removed, and many farmers who selected land upon which there was a living brook of clear, pure water, now find that the brooks dry up during a considerable portion of the year."

Even in the State of Tennessee,, where comparatively but little of the original timber has been cut, the same results are manifest. Hon. J. B. Killebrew, late commissioner of agriculture of that State, relates that, upon visiting the home of his childhood, a short time ago, he was surprised to find what at the time he left his childhood's home, thirty years previously, was a considerable stream flowing through his father's farm, had entirely disappeared, and its former bed had been plowed up. The reason for it he found in the removal of the forests along both its banks. A striking illustration of the total disappearance of a running stream is found here in Cincinnati. Deer Creek, in the boyhood of residents of this city now of middle age, flowed with a stream of sufficient volume to turn a mill. The denuding of the hillsides, and the consequent exposure of the entire surface to the rays of the sun, have dried up the springs which formerly fed it, and no water now flows in its former bed.

The effect upon the larger rivers is no less marked. In this country the lack of interest in this subject has prevented the collection of statistics, extending over a number of years, such as would be trustworthy. But in Europe, where the preservation of the forests has engaged the attention of the governments, careful records have been kept.

In a pamphlet republished by the United States Government, Gustave Wex councilor of state of Austria, gives an exhibit of the average annual decrease in the height of the water in a number of rivers. These observations extended over a number of years, and show that the sinking of the water surfaces has become much greater in the last two or three decades than formerly. This is explained by the fact that during these years there has been a greater amount of clearing, drainage of ponds and marshes, and improvement and irrigation of large tracts. The average decrease, while not large, is alarming, inasmuch as it shows the possible danger of the future. We have selected seven of the rivers, all of which are known to every schoolboy.

Names of rivers and gauge stations.	Sinking of annual mean of the gauge readings. In inches.
Rhine—Basle	0·114
Bingen	0·24
Emmerich	0·40
Danube—Stein	0·41
Vienna	0·425
Old Orsova	0·9
Elbe—Dresden	0·197
Madgeburg	0·394
Vistula—Cracow	0·433
Kurzebrack	0·558
Oder—Kustrin	0·114
Seine—Paris	0·59
Mississippi—Natchez	0·697

In the same pamphlet it was stated that the volume of water at the lowest stage of the river Sele has decreased 33 per cent during the last 150 years; that of the river Brenta, at Bassano, 7 per cent. between 1864 and 1877, and that of the river Adda, where it flows out of Lake Como, 13 per cent. between 1842 and 1862, due in each case, says Senator Torrelli, of Italy, to the clearings around their feeders.

A remarkable illustration of the fact that the clearing of hilly countries is likely to result in the complete failing of springs is given by Mr. Ney, who states that in the Provence, after all the olive trees which there formed regular forests, had been frozen in 1822 and cut down, a great number of springs failed totally, and that besides, in the city of Orleans, after the surrounding heights had been thus cleared, nearly all the wells dried up, and it became necessary to conduct the head-waters of the river Little Loire into the city.

At the time of the Roman rule in France, the river Durance, south of Avignon, and the Seine were navigable rivers and richly supplied with water, so much so that the navigators of the Durance formed an influential corporation; and the Emperor Julian, who resided in Paris during a period of six years, particularly extols the constant, even stage of the Seine. At present, since the regions of the headwaters of these two rivers have been cleared, the Durance can hardly float a skiff in summer, and the Seine, in which the difference between high and low water stage is now 32 feet 10 inches, was only made navigable again by the construction of numerous wing-dams.

At the International Congress of Land and Forest Culturists at Vienna, a few years ago, it was stated that there had been a gradual decrease in the depth of the large streams of all countries. In some cases, it was said, rivers which in former years had been of considerable magnitude, had entirely disappeared. The Rhine, the Elbe, and the Oder are all shallower than formerly. The waters of the Elbe diminished in depth ten feet in fifty years. The decrease in the waters of the Elbe was attributed to the reckless destruction of the forests of Bohemia, where it rises, while that of the Rhine was attributed to the felling of the trees in Switzerland, where are found the sources of that famous river.

But history and observation tell us some things that are more impressive even than the statistics of scientific investigations. Every reader of Bible history and geography knows that for centuries Palestine abounded in little streams, and from nearly every hill gushed forth water. But this is not the case to-day. While the channels of these streams remain they are totally dry, except in the rainy season. That water was formerly abundant is evidenced by their great number. And the absence of trees in Palestine is to-day as marked as the absence of water in these dry channels. Recent explorers have also expressed the opinion that the cutting away of forests along the Jordan and other tributaries of the Dead Sea has so reduced the water in that sea that the influx has not for many years been equal to the evaporation, and that the sea level is in consequence much lower than before the time of Christ. In striking contrast with this is the well known fact that since the planting of trees in Utah the waters of Salt Lake have risen very perceptibly. In the days of Babylon the Euphrates was so bountifully supplied with water that not only did it inundate the fields and spread over the plains, like the Nile, but it rendered necessary great precautions to prevent the famed city from being washed away by its waters. But this is not so now. A traveler, M. Oppert, says that the Euphrates does not now fill its banks; the canals which were used to divert its waters from the cultivated fields, are dry; and the marshes become dry during the powerful heats of summer. This diminution of water he ascribes to the clearing off of the forests on the mountains of Armenia.

M. Becquerel, in his essay on the "Climatic Effects of Forests," gives a number of instances of similar effects. M. Saussure, he says, notices the diminution of waters in the Swiss lakes as a result of clearing, especially in Lakes Morat, Neufchatel, and Bienne. Choiseul Gouffier was unable to find the Scamander River, which, in the time of Pliny, was still navigable. Its bed is now entirely dry, and the cedars that once covered Mount Ida, where it took its rise, no longer exist. The history of Ovideo and the observations of Humboldt show that, owing to the removal of the forests the city of New Valencia, in Venezuela, at the time of his visit, was very much farther away from Lake Tacarigua than when it was first settled, and that the waters of the lake had receded to the same extent. Boussingault, in 1822, learned from the inhabitants that the waters of the lake had risen, and that lands formerly cultivated were under water. Previous to that time there had been a twenty-two years' war, during which the population in the valley had decreased, the lands were uncultivated, and the forests, which in the tropics grow with great rapidity, had been restored. Between 1826 and 1830 the inhabitants of the metalliferous mountains of Marinato increased from a few negro slaves to three thousand workmen. Numerous establishments were erected, to supply which, and for other necessary purposes, much of the wood had been cut. Within two years the effects of the clearings were seen in the decrease of the waters used in driving the mills, and that, too, while a rain-gauge showed that a greater amount of water had fallen during the second year than during the first. The lakes in the valley of Mexico have greatly contracted since the time of the Aztecs. The city of Mexico occupies its ancient site; but instead of being on an island, as formerly, it is some distance from the shore. This is attributed to the felling of the forests that in olden times clothed the neighboring hills.

But while the more level lands need to be, in some degree, covered with trees, in order to prevent the extremes of floods and drought, this is especially the case with mountain lands.

The mountains are natural forest lands, and up to a certain elevation should be perpetually covered with trees. To settlers living at the base of mountains, the forest trees are of incalculable value, for by excluding the sun they prolong the melting of the snows, absorb a large percentage of that which has melted, prevent it flowing off in a flood, and carrying death and destruction to all that may lie in its track. And the fallen trees and branches, the undergrowth, the mosses and other herbage among the decaying leaves, and the millions of leaves break the force of the falling rains, which come quietly to the earth, and sink into the soil until they reach internal cavities or porous strata, from which they are gradually distilled through perennial springs that keep up a constant and regular supply for the streams.

The evil results of the cutting away of mountain forests are especially seen in the valleys and plains of the Alpine regions of France, Italy, and Switzerland, where torrents have wrought fearful destruction. John Croumbie Brown, for many years botanist of the Cape of Good Hope, in his "Reboisement in France," says that at times one of these will fall like thunder. It is announced by a rumbling roar in the interior of the mountain range, and at the same time a furious wind escapes from the gorge. In a few moments the torrent appears in the form of an avalanche of water, rolling before it a heaped-up mass of blocks of stone. This enormous mass forms a moving barrier, and such is the violence of the impulse that the stone may be seen leaping before the waters become visible. M. Gentil says that torrents are one of the most disastrous plagues of the high Alps, and Surrell says that the wild waters flowing in broad sheets over the surface of the ground, without bed, without ravine, have destroyed villages and ruined whole districts, which have been abandoned for ever.

The history of France abounds in illustrations of the destructive power of these mountain torrents. The floods in the valley of the Garonne, six years ago, destroyed, it is estimated, fifteen thousand lives. The losses of life and property caused by these torrential floods induced the French Government, a few years ago, to take steps to reclothe the mountains with trees and vegetation. It is estimated that it will take one hundred and fifty years before the work contemplated is fully accomplished; but encouraging results have already followed the little that has been done.

Mr. Brown states that like damage, only in much less degree, has been done by the mountain torrents of South Africa. One which occurred in 1868 damaged public property alone to the amount of $250,000, and private property about half a million dollars. By the floods of 1874 damage was done to the public works alone amounting to about a million and a half of dollars.

Illustrations showing the great loss of both life and property occasioned by torrential floods could be multiplied indefinitely, but the few cited ought to be sufficient to show that they are a calamity which great pains should be taken to prevent. That they are possible in the mountain regions of the United States was shown by the recent disastrous flood in Pennsylvania, when streams rose so rapidly that people were glad to escape with their lives, and lost property valued at several million dollars. While it is not to be supposed that torrents can be wholly prevented by mountain forests, it is certain that they can be modified to such an extent as to prevent their doing much serious damage.

But there are possible results following the drying up of the streams through the unlimited destruction of forests that should alarm the American people, and cause them to make greater effort to preserve the forests in localities where they now exist and their cultivation where they do not. How terrible these results may be is seen in the desolation wrought upon Babylon, Nineveh, Thebes, Memphis, and especially upon the Chinese province of Shan-Li only three years ago, by the loss of their forests. History shows that not a few nations have declined with the disappearance of their forests; and upon the preservation of our water-courses may depend our existence as a nation. While the government ought to protect its own forests, and especially its mountain forests, it is the farmers and other small land-owners who can effect the most good; and every influence possible should be exerted to induce them to reclothe a portion of their denuded lands. In this work the most effective agency would be the press, particularly the agricultural press; and it is to be hoped that it will agitate the subject until the desired result is brought about.

STUDENT-LIFE IN VIENNA.

MOST of the American medical students are making a specialty of the eye, ear, and throat. The clinical material here is immense. The finest of all is the touch course, in the lying-in ward. It is worth a trip for that alone. In one course you have the opportunity of examining at least one hundred pregnant women, in all the different stages, and of applying the forceps and other manipulations, under the guidance of the professor. There is nothing that can bear favorable comparison to it in America.

Excepting Paris, Vienna is the most expensive city in Europe. The climate is exceedingly changeable, demanding of one great discretion as regards clothing. Please allow me to correct a false impression that nearly all Americans possess regarding the cheapness of student-life in Europe. If a student attends all the courses he wishes and obtains comfortable board, it is not possible to spend less than one hundred dollars per month. This is even calculating very closely, for everything is very dear.—*Cor. of College and Clinical Record.*

A CATALOGUE, containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

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